A

TECHNICAL REPORT

ON

STUDENT INDUSTRIAL WORK EXPERIENCE SCHEME (SIWES)

UNDERTAKEN AT

IHUBE YARD, OKIGWE L.G.A,

IMO STATE

BY

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SUBMITTED TO

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FEBRUARY, 2020.

CERTIFICATION

This is to certify that this report is a detailed account of Student Industrial Work Experience Scheme (SIWES) undertaken by **BOLAJI REUBEN AYODEJI** with matriculation number **CVE/15/2295** at SETRACO NIGERIA LIMITED, IHUBE YARD IN IMO STATE, for a period duration of SIX months, and has been prepared in accordance to regulations guiding the preparation of SIWES reports in the Department of Civil Engineering, The Federal University of Technology, Akure.

_____	_____
Student	Date
_____	_____
Supervisor Signature	Date
_____	_____
Head of Department	Date

DEDICATION

This project report is dedicated to the Most High God for the grace and strength bestowed upon me to successfully complete this work.

ACKNOWLEDGEMENTS

The compilation of this Report and the overall success of the SIWES program was possible due to the immense contributions of numerous people both in the field and outside the field; I would like to acknowledge God for the strength to go through this period without much pain and sickness.

I am ever mindful of the prayers and support of my parent Mr. and Mrs. Bolaji W.A and my siblings for always reminding me that they are my number one support team.

I appreciate the efforts of the Head of laboratory; Mr Dirisu Emanamhe, the Personnel manager; Mr. Dennis Kprake and the Asphalt production Supretehindent; Mr. Akin Williams, for accepting and giving me their support as regard my period of stay at Setraco Nigeria Limited.

To my hardworking trainers in the laboratory, from whom I have learnt much from; Mr. Essien Akpan, Mr. Mbamalu Mandella, Mr. Onyeka Okereke, Mr. Kabiri Christopher, Mr. Monday Sule, Mr. Isaac Udo Bassey, Mr. Michael Una Udo, Mr. Oyakhilome Michael, Mr. Victor Bright and my colleague; Nwankwo Prince – all of whom I appreciate.

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CHAPTER ONE

1.1 INTRODUCTION

The Student's Industrial Work Experience Scheme (SIWES) is a programme that is facilitated by the Industrial Training Fund (ITF) to stop inadequate training among the students. This programme is part of the academic curriculum of students in faculties of Engineering, Technology, Environmental Sciences and pharmacy etc. and also forms part of the approved Minimum Academic Standards in the various degree programmes for all the Nigerian Universities. The introduction and entrenchment of the law that gave birth to Industrial Training Fund has done a great deal in training and retraining students so as to meet and provide effective services needed to produce high quality goods and services in our dynamic economy. The Student Industrial Work-Experience Scheme (SIWES) is a planned and supervised training intervention based on stated and specific learning and career objectives, geared towards developing the occupational competencies of the participants

The highly proliferating concerns of the industrialists that graduates from our institutions of higher learning do not have enough pragmatic understanding of their courses of study has led to the introduction of Students' Industrial Work Experience Scheme (SIWES).

It is an effort to bridge the gap existing between theory and practice of engineering and technology, sciences, agriculture, medical, management and other profession the Nigerian tertiary institutions. It is aimed at exposing students to machines and equipment, professional work methods and ways of safe-guarding the minimum duration for the SIWES should be 24weeks except for engineering and technology programmes where the minimum duration is 40weeks, the scheme is a tripartite programme, involving the students, the universities and the industry (employers of labour). The participants in the SIWES programme are:

A. 59 UNIVERSITIES
B. 85 POLYTECHNICS
C. 62 COLLEGES OF EDUCATION

SIWES is a program organized for students of higher institution to acquire practical knowledge of their various discipline in a real standard establishment different from the kind of experience or knowledge gained within the school laboratory.

Consequently, the effectiveness of SIWES cannot be looked at in isolation with respect to a single discipline; it is better explored in a holistic manner since many of the attributes, positive outcomes and challenges associated with SIWES are common to all disciplines participating in the scheme.

Hence, the approach of this report is to look at SIWES as a general study programme cutting across several disciplines. Nevertheless, the report also pays attention to the peculiarities and problems associated with effective implementation of SIWES for engineering and its effectiveness in contributing to the professional development of the engineering students.

The Student Industrial Work Experience Scheme, SIWES is a new directorate under the Vice Chancellor's office. It was established on 20th April, 2012. The scheme is a skill training programme designed to expose and prepare students of universities and other tertiary institutions for industrial work situation they are likely to meet after graduation. It is also planned and structured programme based on stated and specific stated objectives which are geared towards developing the occupational competence of participants.

1.2 HISTORY OF SIWES

The Students' Industrial Work-Experience Scheme (SIWES) was established by the Industrial Training Fund (ITF) in 1973 with 748 students from 11 institutions of higher learning participating. By 1978, the scope of participation in the scheme had increased to about 5,000 students from 32 institutions. The Industrial Training Fund, however, withdrew from the management of the scheme in 1979 owing to problems of organizational logistics and the increased financial burden associated with the rapid expansion of SIWES. Consequently, the Federal Government funded the scheme through the National Universities Commission (NUC) and the National Board for Technical Education (NBTE) who managed SIWES for five years (1979 – 1984). The supervising agencies (NUC and NBTE) operated the scheme in conjunction with their respective institutions during this period.

1.3 ORGANIZATION AND OPERATION OF SIWES

The organization of the Students' Industrial Work-Experience Scheme (SIWES) involves many stakeholders as follows:

- Federal Government (Federal Ministry of Commerce & Industry)

- Industrial Training Fund (SIWES Division)
- Supervising/Regulatory Agencies (NUC, NBTE, NCCE)
- Industry/Employers (NECA, NACCIMA, MAN, Government Establishments)
- Tertiary Institutions (Universities, Polytechnics, Colleges of Education) and
- Student Trainees (Engineering, Science, Technology, NCE Technical)

1.4 AIMS AND OBJECTIVES OF SIWES

The industrial Training fund's Policy Document No.1 of 1973 which established SIWES outlined the objectives of the scheme as follows:

- Prepare student for industrial work situations that they are likely to meet after graduation;
- Make the transition from school to the world of work easier and enhance students' contacts for later job placements;
- Provide students with the opportunities to apply their educational knowledge in real work situations, thereby bridging the gap between theory and practical;
- Enlists and strengthens employer's involvement in the entire Educational process of preparing university graduates for employment in industry.
- Provide an avenue for students in institution of higher learning to acquire industrial skills and experience during their courses of study.
- Expose student to work methods and techniques in handling equipment and machinery that may not be available in their institution.
- Maintain a balance between theoretical and practical knowledge.
- Advancing relationship between educational and industrial sectors.

CHAPTER TWO

2.1 ABOUT THE COMPANY

Setraco Nigeria Limited is a leading engineering construction company with over 35 years working experience in delivering value-added civil and infrastructural projects. With projects executed successfully in over 20 states, and current presence in 15 states, with the head office located at Plot 526, ShehuYar'Adua way, Kado district, Abuja. Setraco has played a key role in developing Nigeria's infrastructure.

Setraco Nigeria Limited was established in 1977 by Alhaji Inu Umoru and started by constructing township and district roads that in what was then Bendel state. Over the years the company has rapidly grown to become one of the largest construction companies in Nigeria specialize in roads and bridges. They are well known for their assurance that all projects are successfully completed to specification and in line with the company's sense of responsibility towards its clients and host communities. The company is also technically partnering with a number of leading design and consulting firms across the globe, which enables them to present their clients with cutting edge solutions for their needs.

2.2 RESOURCES

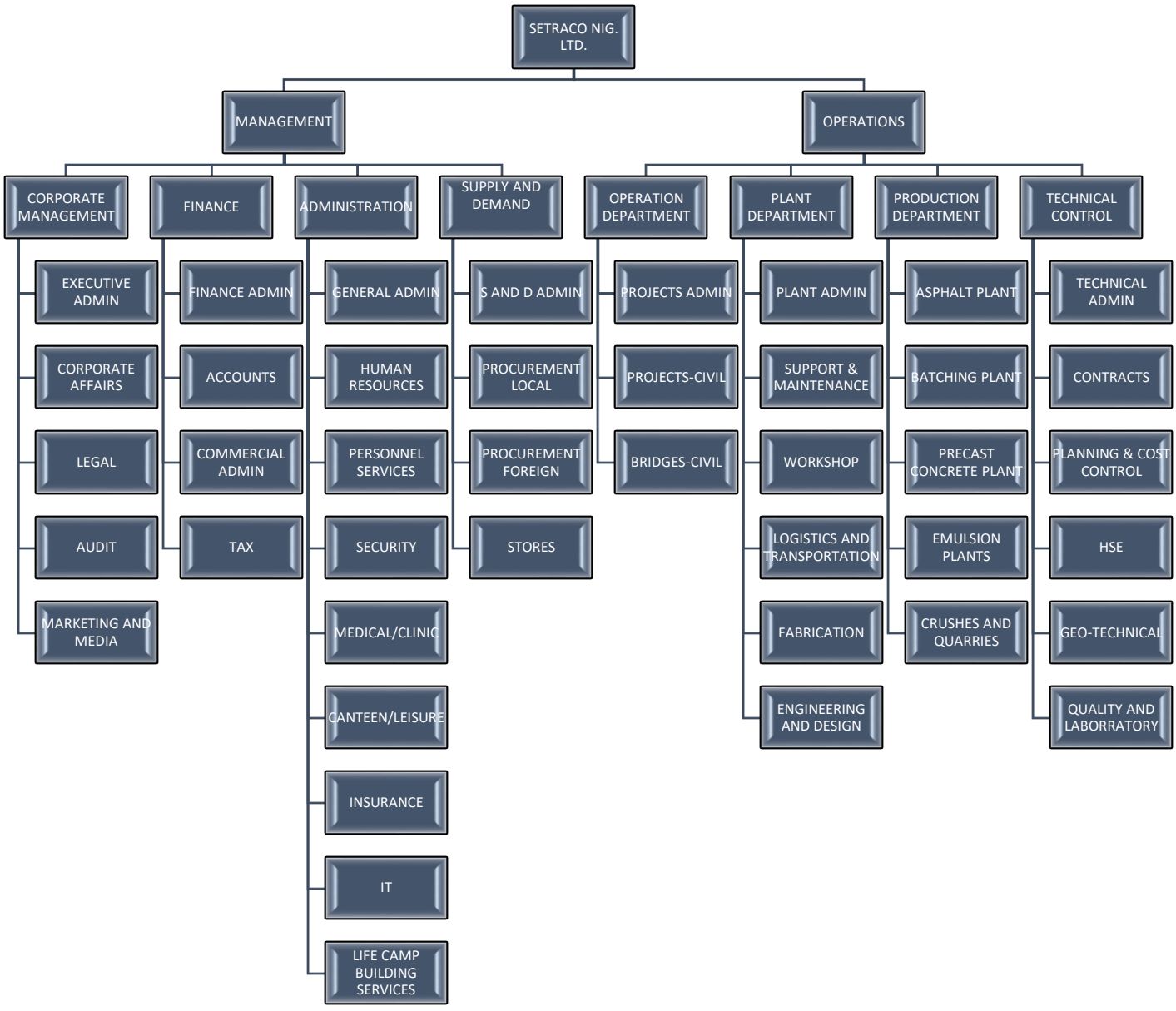
Setraco success is built upon its diverse and qualified workplace which at times has reached over 11,000 employees from all corners of Nigeria and from 23 various nationalities across 6 continents. By recruiting the best professionals and technicians from all disciplines, Setraco is able to take on and deliver complex projects in difficult terrains and challenging environments. The company's fleet of modern and periodically updated equipment is worth over 200,000,000 US Dollars, and its state of the art workshops around the country.

2.3 JOBS UNDERTAKEN AT SETRACO NIGERIA LIMITED

The jobs undertaken at Setraco Nigeria Limited, Ihube Yard are stated as follows;

1 Construction.
2 Highway Engineering
3 Asphalt production.
4 Material Testing.
5 Geotechnical Engineering
6 Leasing out construction equipment and machineries.

TABLE 2.1 ORGANIZATION STRUCTURE OF SETRACO NIGERIA LIMITED



2.4 DEPARTMENTS IN SETRACO NIGERIA LIMITED.

Departments in setraco Nigeria Limited varies from branch to branch depending on the projects being handled and operations being carried out. Setraco Nigeria Limited, Ihube Yard is an engineering construction branch thus the various department there in includes:

2.4.1 Administrative department

Administration department of the organization includes the personnel admin section, project management section, accounting section, commercial admin section, transportation management, etc. The preparation and organization of relevant paperwork, management of databases, arrangement of travels and accommodation, arrangement of logistics and deliveries, among others are the concern and function of the administrative department.

2.4.2 Workshop Department

The workshop departments includes the mechanical section, electrical section and information Technology section. The department is responsible for the preventive and corrective maintenance of the organization's electrical and mechanical devices, machines, plant, structures and vehicle. The workshop is equipped with spare parts, tools, equipment, machines etc.

2.4.3 Federal Ministry of works department

The federal Ministry of works department attached to the company, is charged with several statutory responsibilities among which are: Federal highways (Planning, Design, Construction and Rehabilitation), supervision of monitoring and maintenance of federal roads. They serve as the client's representative on the project.

2.4.4 Surveying department

The surveying department is responsible for the determination of terrestrial or three-dimensional positions of points and the distances and angles between them on the surface of the earth for various construction purpose.

2.4.5 Store Department

The store department preserve and store materials, finished goods; consumable and non-consumable, perishable and non-perishable, purchases and issue the material or goods when requested for. The store is centralized to serve various departments within the organization. The store department includes the receiving section, storage section, accounting section and issue section.

2.4.6 Filling Station

The filling station is a facility of the store department, responsible for distributing fuel for vehicles and machineries used for operation on the project.

2.4.7 Security department

The security department is responsible for the security of institution's property and workers. The department includes armed forces within the yard, armed forces as escort, security personnel distributed to specific departments, gate keepers, etc.

2.4.8 Clinic department

The clinic department provides primary health care to workers in the organization. The medical facility in the clinic department treat the illness or injuries of workers. An ambulance is attached to the department for emergencies and cases that involves transportation.

2.4.9 Scale / Weigh bridge department

The scale department monitors and weigh vehicles, loaded or unloaded through the weigh bridge. The scale department provide exact figures to maintain goods inward and goods outward the yard. The weighbridge is mounted by the weighbridges manufacturer on a concrete surface with a digital monitor which displays the weight of vehicle weighed.

2.4.10 Quality Control Department

The quality control department ensures products and services comply with requirements. The department filter products before reaching the client. A fully equipped material testing laboratory, where various tests are carried out; is attached to the department.

2.4.11 Concrete department

The concrete department is responsible for the mixing and production of concrete pertaining to the project using cements, reinforcements, coarse and fine aggregates, admixtures and water. It includes the batching plant, form works, mixer trucks, a wide variety of equipment used for processing concrete, from hand tools to heavy industrial machineries, and also saddled with the responsibility of ensuring the proper casting of concrete at the various sites.

2.4.12 Asphalt production Department

The department controls and supervise the mixing process to produce asphalt from aggregate and bitumen for road construction. The heart of the asphalt production department is the Asphalt Plant. The department includes different sections of operations.

CHAPTER THREE

3.1 WORKDONE AND EXPERIENCE GAINED

At Setraco Nigeria Limited, Ihube Yard, I worked in the material testing laboratory of the Quality Control Department for the rehabilitation and reconstruction of Enugu – Portharcourt Dual carriage way. The quality control processes involved in the highway construction, which includes the various laboratory and field tests carried out on the materials that forms parts and layers of the highway; where explored. The followings describes the layers of the highway, materials that forms each layer, and the tests carried out on the materials that forms various layers and highway drainage for the purpose of quality control.

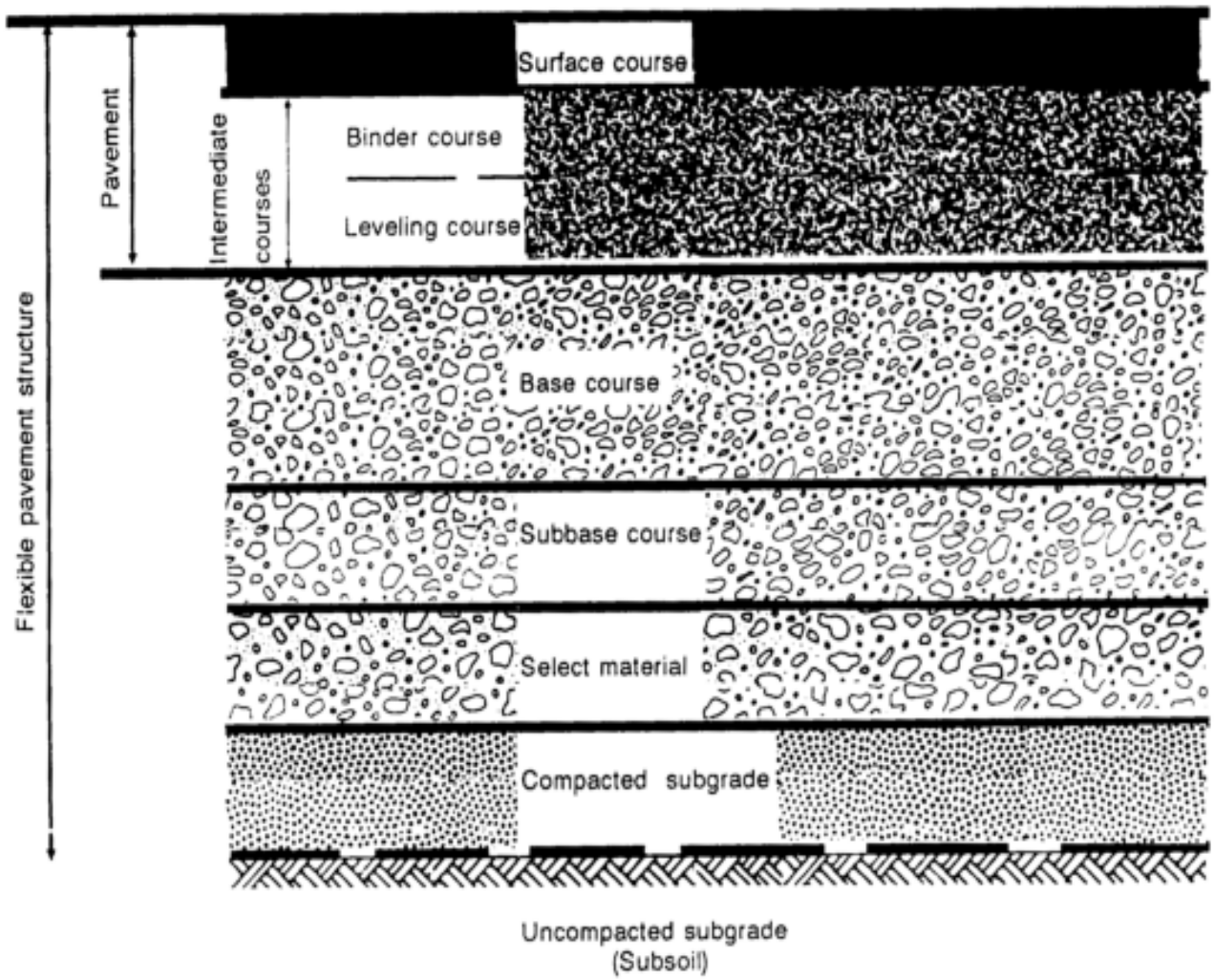


Figure 3.1 Flexible Pavement Section

All layers and coats are not present in every flexible pavement highway. Intermediate courses may be placed in one or more lifts. Tack coats may be required between the intermediate courses and under the surface course. A prime coat may be required between the highest aggregate surface and the first layers of the asphalt.

Table 3.1 Layers with their constructive materials and respective tests

HIGHWAY LAYERS / PARTS / MATERIALS		**MATERIALS**	**TESTS CARRIED OUT / QUALITYCONTROL MEASURES**
Surface course (Pavement)	Wearing course Binder Course	Asphalt (Aggregate, sand, bitumen)	(1) Bitumen Penetration test (2) Bitumen density Test (3) Marshall properties (4) Bitumen Extraction and sieve analysis of Aggregate (5) Specific gravity of Sand (6) Specific gravity of Aggregate (7) Elongation Index of Aggregate (8) Flakiness index of Aggregate
Prime Coat		Cutback Bitumen	Rate of Spray Test
Base course		Stone Base (Aggregate mixed with sand)	(1) Sieve Analysis of stone base (2) Compaction Test (3) Specific gravity of stone base (4) Los Angeles Abrasion Test (5) Aggregate Crushing Value (6) Compacted (roded) Bulk density (7) Uncompacted (loose) Bulk Density (8) In-situ Density test
Sub-base course		Sand mixed with Cement	(1) Sieve Analysis of sand (2) Maximum dry density and moisture content Test – also known as compaction test (3) Sand-Cement Stabilization (4) Unconfined Compression Test (5) Specific gravity and Water absorption Test (6) In-situ Dry Density Test (7) California Bearing Ratio Test

Sub-grade course	Milled Asphalt mixed with laterite (pulverized material)	(1) Sieve Analysis (2) California Bearing Ratio Test (3) Liquid Limit and Plastic Limit Test (4) Compaction Test
Highway drainage	Concrete (cement, sand,aggregate,H_2O)	(1) Slump Test (2) Concrete Cube Test

3.2 FUNCTIONS OF THE QUALITY CONTROL DEPARTMENT

1. Develop and determine all standards to perform inspection and tests on all procedures and oversee all testing methods and maintain high standards of quality for all processes.
2. Review quality of all materials at site and ensure compliance with all project specifications and quality and collaborate with the department for all material procurement and maintain the quality of materials.
3. Supervise effective implementation of all tests and inspection schedule and ensure adherence to all procedures and coordinate with various teams to perform quality audits on processes.
4. Assist with employees to ensure knowledge of all quality standards and ensure compliance with all quality manual and procedures and collaborate with contractors and suppliers to maintain quality of all systems.
5. Manage to lift all equipment and handle efficient storage of all hazardous materials and perform quality audits as per required schedule.
6. Analyze all products and non-conformance processes and evaluate all documents to ensure maintenance of optimal quality and prepare monthly reports to evaluate performance.
7. Monitor an efficient system and record for all project activities and analyze all processes to ensure all work according to quality requirements.
8. Manage all work methods and maintain knowledge on all quality assurance standards and monitor continuous application for all quality assurance processes and recommend corrective actions for all processes.

3.3 NATURE OF PROJECT

Setraco secures the contract for the total rehabilitation and reconstruction of 60kms, of previously dualized highway between Lokpanta and Umuahia along the Portharcourt – Enugu Express way.

CLIENT: FEDERAL MINISTRY OF WORKS

NAME OF CONSULTANT: TISCO AND PARTNERS

MONTH AWARDED: SEPTEMBER, 2013

MONTH COMPLETION: ONGOING

Enugu to Portharcourt dual carriage way is a federal road with an approximate distance of 233kilometres (145 miles). Setraco Nigeria limited handles Lokpanta to Umuahia phase of Enugu

– Portharcourt express way which is an approximate of 120 kilometers. Two other contractors secures the other phases of the road namely; China Civil Engineering construction corporation (CCECC) for the Enugu – Lokpanta phase and Arab Contractors Nigeria Limited for the Umuahia – Porthacourt phase of the road. The contract is worth 30 Billion naira.

3.4. LABORATORY TOOLS, EQUIPMENTS AND MACHINES

Some tools, equipments and machines used as apparatus for various tests carried out in the laboratory for the purpose of quality control are described as follows:

3.4.1 Mallet

A hammerlike tool with a head commonly of plastic, wood, rubber or similar non-iron material, used for striking a face.

3.4.2 Spanner

A spanner is a tool used to provide grip and mechanical advantage in applying torque to turn objects-usually rotary fasteners, such as nutsand bolts. They are of two type namely; the open ended spanner and the ring spanner. Very useful in the assembling and disembling of the concrete cube mould.

3.4.3 Pickaxe

A standard pickaxe has a poinnted end on one side of its head and a broad flat ‘axe’ blade opposite. The pointed head is used both for breaking and prying while the axe is used for hoeing, skimming, and chopping roots.

3.4.4 Florence/Boiling flask

It is used to hold liquids and can be easily swirled and heated. It can also be capped with rubber or glass stoppers. Safety dictates that theis flask can never be heated when capped to avoid explosions due to pressure build-up.

Plate 3.1 Mallet

Plate 3.2 flat and ring spanner

Plate 3.3 Pickaxe

Plate 3.4 Boiling flask

3.4.5 Hard sieve brush

Hard sieve brush made of brass wire for cleaning coaser wire cloth.

3.4.6 Head pan

Head pan is made of Iron and used in moving or transporting samples of soil, aggregate, asphalt, etc. either within the laboratory or from the stockpile to the laboratory.

3.4.7 Industrial gas cooker (Triple burner)

This industrial gas cooker, constructed with strong metal place is used for cooking, heating, boiling, drying processes in the laboratory. Its source of fuel is natural gas which is very efficient and cheap.

Plate 3.7 Industrial Gas cooker

Plate 3.6 Head pan

Plate 3.5 Hard sieve brush

3.4.8 Set of Sieve

A set of sieves is used ito assess the particle size distribution (also called graduation) of a granular material by allowing the material to pass through a series of sieves of progressively smaller mesh size.

3.4.9 Pestle and Mortar

A Mortar is a vessel in which substances are ground or crushed with a pestle. A pestle is a tool used to crush, mash or grind materials in a mortar. The mortar and pestle is constructed using hard material such as cermic.

Plate 3.8 Sets of Sieve

Plate 3.9 Pestle and Mortar

3.4.10 ACV mould and Tamping rod

Aggregate compressive value mould set consists of 150mm steel cylinder, plunger, base plate and steel tamping rod; for carryiong out aggregate compression test.

3.4.11 WHEELBARROW

Wheelbarrows are used for conveying concrete,soil samples or aggregates sample from the mixing plant or deposit as the case may be, to the laboratory.

3.4.12 RAMMERS

An instrument for driving by impact. The impact force of a rammer causes a shearing effect that squeezes out air voids and excess water between the particles. Rammers are used to give blows when carrying out compaction and CBR test. The compaction rammer weighs 4.89kg with a handle.

3.4.13 WASH BOTLES

Wash bottles are used for dispensing small quantities of distilled water.

Plate 3.10 ACV mould

Plate 3.11 Rammer

Plate 3.12 Wash bottles

3.4.14 CBR SET

The CBR set consists of the Cylindrical mould, collar, spacer disc, surcharge and compaction rammer.

Plate 3.13 CBR mould set

Cylindrical mould: Inside diameter of 150mm and height 175mm with a detachable perforated base plate of 235mm diameter and 10mm thickness. Net capacity – 2250ml; conforming to IS-9669:1980 (Reaffirm-2016).

Collar: A detachable extension collar of 60mm height.

Spacer Disc:148mm in diameter and 47.7mm in height along with handle.

Perforated/unperforated cover: The perforated cover is screwed to the base of the cylindrical mould, while the unperforated cover is screwd to the top before soaking.

3.4.15 HEAVY DUTY INDUSTRIAL LABORATORY OVEN

These robust ovens are used in the laboratory for drying, heating melting and curing processes of material samples, tools, substances etc. This model has a corrosion resistant coated steel chamber with two doors. It uses special timers and safety thermostat and indicator.

3.4.16 SAND ABSORPTION AND SPECIFIC GRAVITY CONE SET

The sand absorption Abraham cone set is used in determining the specific gravity and water absorption of fine aggregates smaller than 10mm.

The cone dimensions are : upper diameter of 40mm, lower diameter of 90mm and 75mm height, and the tamping rod has a 25mm base diameter and approximate 340g in weight.

Plate 3.14 Heavy duty Laboratory Oven

Plate 3.15 Abraham Cone

3.4.17 SPADE

A spade is used for collection, mixing of samples, concrete and turning works.

3.4.18 THE SPECIFIC GRAVITY BENCHAND WIRE MESH BASKET

The specific gravity (relative density) basket allows easy suspended weighing of samples in water for relative density determination of aggregates, hardened concrete, bituminous mixtures, refractory brick and similar materials. Wire basket is suspended inside the water tank.

3.4.19 VOLUMETRIC/GRADUATED CYLINDER

This is a primary measuring tool for the volume of a liquid. There are several markings up and down the length of the container with specific increments. Graduated cylinder come in various sizes. The smaller they are in diameter, the more specific the volume measurements will be.

3.4.20 VOLUMETRIC FLASK / PYCNOMETER

Volumetric flasks are used to measure precise volumes or to make precise dillutions.

3.4.21 BEAKER

A beaker is used for mixing, stirring, and heating substances. Most beakers have sprout on their rims to aid in pouring. They also have markings to measure the volume they contain.

Plate 3.16 Wire Mesh Bask Plate 3.17 Cylinder Plate 3.18 pycnometer Plate 3.19 Beaker

3.4.22 WATER TANK

The water tank serve as a reservoir of water stored at room temperature.

3.4.23 FUNNEL

Funnels are used to channel liquid or fine-grained substances into containers of smaller opening to prevent spillage. A laboratory Funnel is just like any other funnel except that it was designed to be used in a laboratory setting. They are made of plastic or glass and can either have a short stem or a long stem, depending on what they are needed for. There are several sizes that can be chosen from based on the amount of liquid that needs to go through them quickly.

3.4.24 CBR MACHINE

The CBR machine consists of the loading with a capacity of at least 5000kg and equiped with a movable head which enables the plunger of 50mm diameter to penetrate into the specimen at a rate of 1.25mm/minute.

3.4.25 SPEEDY MOISTURE TESTER

The moisture content of soil, sand and other fine grained material can be obtained quickly with reasonable accuracy from the **Calcium carbide digital scale**. It measures the relation of the weight of water in a volume of soil to the weight of the solid particls in that volume. The amount of gas that is given off when water is mixed with calcium carbide, is directly proportional to the amount of water present in the sample.

3.4.26 RIFFLE BOX

The riffle box is used during sample preparation to reduce a bulk sample of aggregate to a smaller quantity; for testing. The riffle box is designed so that material poured in the top is divided approximately equally and diverted to two sides. The division is homogenous. The box contains about 12 chutes discharging at alternate sides.

3.4.27 SPATULA

Spatula is used in a wide range of laboratory and field testing procedures, for material mixing, lifting, levelling,stirring, and in handling powders, granular materials and other solids.

3.4.28 SCOOP (ROUND BOTTOM)

The round bottom scoop is constructed of corrosion-resistant stainless steel and is used for laboratory or field handling of sample materials.

Plate 3.20 CBR machine

Plate 3.21 Riffle Box

Plate 3.22 Spatula

Plate 3.23 Scoop

Plate 3.24 Speedy Moisture Tester

3.4.29 IN-SITU DENSITY CONE APPARATUS (SAND REPLACEMENT TEST)

This apparatus is used to for the determination of the degree of compaction on a road site. And the complete set consists of a pouring cylinder, container and tray.

3.4.30 LOS ANGELES (LA) ABRASION MACHINE

The Los Angeles Abrasion machine is used for the determination of aggregates resistance to fragmentation. The test is used widely as an indicator of aggregate quality.The test measures the degradation of standard gradings of aggreagtes subjected to abrasion and impact in a rotating steel drum containing of abrasive charge of steel balls. The machine consist of an electronic control unit and a rolled steel drum having an inside diameter of 711mm and internal length of 508mm. The drum is rotated at a speed of 31-33 revolutions per minute. The machine is equiped with an automatic counter, when the preset revolution count is reached, the machine will stop automaticaly

automatically. The drum is equiped with an interlock device which allows the operator to lock the drum for easy loading/unloading of the sample. A steel tray is supplied with the machine for easy discharge of specimen and abrasive charges.

3.4.31 COMPRESSION MACHINE (WITH PRO CONTROLLER)

The compression machine is outfited with accessory fixtures to accommodate compressive testing of different size of cubes, cores, mansory prisms and cylinders, as well as flexural beam specimens.

3.4.32 SLUMP CONE

The slump cone is made of steel with a top diameter of 10cm ,bottom diamter 20cm and height 30cm, used for slump test; the determination of the workability of concrete. It is used along with a 600mm long and 16mm diameter tamping rod, funnel, ruler and metal base plate.

3.4.33 TRAFFIC CONES

Traffic cones also called pylons, witches' hat, road cones, highway cones, safety cones, channelizing cones or construction cones, are ususally cone shaped markers that are placed on the roads or footpaths to temporarily redirect or divert traffic. The reflective sleeves are for night time visibility.

Plate 3.25 In-situ Cone

Plate 3.26 Compression Machine

Plate 3.27 UC Machine

Plate 3.28 Slump Cone

Plate 3.29 Traffic Cone

Plate 3.30 LA Abrasion Machine

3.4.34 UNCONFINED COMPRESSION (UC) MACHINE

The unconfined compression machine is used for determining the compressive strength of undisturbed or remolded soil sample.

3.4.35 MEASURING BOX

The measuring box is used to measure the quantity of quantity of sand or aggregate used for making concrete. The volume of measuring box is generally 1 cubic feet, which makes it easy to measure concrete ratio or mortar ratio. It is very useful in conveying asphalt from the laboratory to the road site for the purpose of patching.

3.4.36 MERCURY THERMOMETER

The mercury thermometer determines the temprature of a body by the means of mercury.

3.4.37 WEIGH BALANCE

Weigh balance is used to measure the weight of any item

3.4.38 THERMA WATER PROOF (TWP) THERMOMETER

The therma water proof thermometer measures temperature over the range of -99.9 to 299.9 degree celcious. It is used in the laboratory for traking the temperature of petroleum products.

3.4.39 HAMMER

A hammer is a simple tool designed to manually drive nails and other fasteners into softer materials such as wood or dry wall.

Plate 3.31 Measuring Box

Plate 3.32 Weigh balance

Plate 3.33 TWP Thermometer

3.4.40 ELECTRIC CONCRETE CEMENT MIXER BARROW MACHINE

Electric concrete mixer barrow machine is used in the laboratory for mixing concrete, powered with electricity and very mobile.

3.4.41 CLIP BOARD

A thin board with a cip a top for holding papers and temporary recording of data.

3.4.42 PRECISION HYDROMETER

Precision hydrometer is used for the determination of the density of fluids, especially liquids heavier than water.

3.4.43 PENETROMETER

Penetrometer offers a quick and handty assessment of firmness based on a unique output parameter defined by the maximum force to disrupt the tissue. A penetrometer is forced into the soil to measutre resistance to vertical penetration (Davidson, 1965). It is designed to give more precise correlation with properties such as bearing value, safe soil pressure, rolling resstance, trafficability of wheels or crawler tracks on soil, relative density etc.

Plate 3.34 Clip board

Plate 3.35 Automatic Compactor

Plate 3.36 penetrometer

Plate 3.37 Hydrometer

Plate 3.38 Concrete Mixer Barrow

Plate 3.39 Extraction Machine

Plate 3.40 C – Spanner

3.4.44 BITUMEN AUTOMATIC COMPACTOR

This equipment is used to speed up the process withease and accuracy to prepare cylindrical specimen for marshall stability testing machine. This apparatus automatically compacts the sample and stops after the preset number of blows is completed.

3.4.45 ASPHALT CENTRIFUGAL BITUMEN EXTRACTION TEST MACHINE

The instrument is used for the determination and checking of bitumen percentage in bituminous mix. The mix is added with solvent and dissolved bitumen is removed by centrifugal action. It consists of a removable aluminium rotor bowl, which is mounted on a vertical shaft that protrudes from cast housing. This shaft and thus the bowl is rotated fast manually by enclosed gears in the cast body and handle.

3.4.46 KUT WATER FINDING PASTE

It is golden brown in colour, upon contact with water, colour turns a brilliant red. Kolor Kut paste successfully guages all petroleum products and by-products for water content and accurately indicate the water/product interface. The absence of colour change by the water paste is your guarantee that no water is present.

3.4.47 C – SPANNER

It is used to fit, mount or dismount mould and collar, used with CBR mould.

3.4.48 FINE SIEVE BRUSH

Fine sieve cleaning brush is ideal for cleaning No. 16 and finer sieves. It has soft, natural bristles, nickeled steel ferrule and a lacquered wood handle.

3.4.49 PAN

Pans are used for handling and storing to processing aggregates and other bulk sample materials for laboratory testing, with round bottom.

3.4.50 SAMPLE TRAY

Trays are shallow containers that have a flat surface and raised edges for transportating or holding supplies, liquids, samples etc.

Plate 3.41 Pan

Plate 3.42 Sample Tray

Plate 3.43 fine brush

Plate 3.44 LL Device

3.4.51 LIQUID LIMIT (LL) DEVICE

The liquid limit device measures the level of water content at which soil changes from liquid to a plastic state (where two halves of a soil sample flow together when jolted in a partiular fashion). It comprises of removable brass cup, adjustable crank and cam mechasim, blow counter and base.

3.4.52 CONCRETE CUBE MOULD AND TAMPING ROD

Concrete cubes are made of cast iron, designed to be durable , corrosion resistant and easy to clean. Concrete cubes have four body part attached to the base with a robust clamp.

3.4.53 ELONGATION GUAGE

Elongation guage is used to measure the length of individual particles and classify aggregate elongation.

3.4.54 FLAKINESS GUAGE

Flakiness index guages measures particle shape of aggregates used in pavement base course applications of asphalt and concrete paving mixes.

3.4.55 SURCHARGE LOADS

Surcharge loads are applied to the soil's surface during soaking and penetration. Rust resistant and weighs 4.5 kilogram, with diameter of 149mm and 54mm slot(center hole).

Plate 3.45 Flakiness guage

Plate 3.46 Concrete Cube

Plate 3.47 Hand trowel

Plate 3.48 Elongation guage

Plate 3.49 Surcharge loads

Plate 3.50 Split mould

3.4.56 Hand Trowel

An hand trowel is a small hand tool used for applying, smoothing, surfaces especially during the decorative finishing of cubes.

3.4.57 Scraper

Scraper is a single-edged tool used for removing fragments of dried concrete from surfaces, especially from the concrete cube moulds.

3.4.58 Split mould

The split mould is used to produce cylindrical specimen for the unconfined compression Test.

3.5 BATCHING PLANT CONCRETE QUALITY CONTROL

A concrete plant, also known as a concrete batching plant, is an equipment that combines various ingredients to form concrete. Some of these inputs include water, air, admixtures, sand, aggregate (rocks, gravel etc.), fly ash, silica fume, slag, and cement. A concrete plant can have a variety of parts and accessories, including: mixers (either tilt drum or horizontal or in some cases both), cement bins, heaters, chillers, cement silos, batch plant controls, and dust collectors.

The heart of the concrete plant is the mixer, and there are many types of mixers such as tilt drum, pan, planetary, single shaft and twin shaft mixer. Conveyors are typically between 24-28 inches wide and carry aggregate from the ground hopper to the aggregate bin, as well as from aggregate batcher to the charge chute.

Concrete grade C20 and C25 are mixed for the construction of U-Drain and trailer park. For the concrete mixing, batching by weight is adopted.

3.5.1 Procedures:

1. Each concrete mixer will go to the weigh bridge to be weighed empty.

2. Eight excavator bucket of the mixed aggregate was inputted to the batcher. The excavator bucket is equal to one cubic meter, so the number of excavator bucket discharged into the batcher depends on the quantity in cubic meter expected to be mixed and delivered. It is not always eight cubic meter.

Plate 3.51 batching plant mixing

3. The conveyor belt was made to carry the mixed aggregates from the batcher to the charge chute and discharged it into the concrete mixer.

4. The concrete mixer plus the mixed aggregate was weighed at the weigh bridge for confirmation, ensuring that the deviation from the expected value does not exceed ±100.

5. Little amount of water was added to the concrete mixer and the required quantity of cement was discharged into the concrete mixer truck.

Plate 3.52 Mixer truck being weight and cement added

6. More water was added to the concrete mixer while the quality engineer monitors the quantity of water being added by climbing the concrete mixer until it is done.

7. Concrete sample for concrete cube casting was collected from the concrete mixer truck and transported to the laboratory.

All through the procedures above, the mixer truck continues to mix for a minimum of 70 to 100 revolutions during transportation to the job site.

3.5.2 Calculations

The density of one excavator bucket of mixed aggregate = 1950kg/m^3

The volume of one excavator bucket = 1m^3.

Volume of concrete mix to be produced = 8m^3.

Density=mass/volume

Mass of mixed aggregate = 8 m^3× 1950kg/m^3 = 15600 kg

(The mass of mixed aggregate will be confirmed at the weigh bridge by subtracting the weight of the empty weighed concrete mixer from the weight of the filled concrete mixer. The mas of the mixed aggregate at the weigh bridge compared to 15600 kg, with the difference not exceeding±100kg.

Mass of Cement = 8 m^3× 275 kg/m^3= 2200 kg

(Each bag of UNICEM cement had been weighed and labelled with their various mass. Ranging from 2100kg to 2500kg. The mass of the cement discharged into the concrete mixer is subtracted from 2200kg, and the remaining mass is sorted by the addition or subtraction of bags Dangote cement which is 5okg each, either by whole or division to complete 2200kg).

3.5.3 Precautions:

1. All concrete mixers were correctly weighed empty at the weigh bridge and also after loading to ensure the mass of expected mixed aggregate is not by-passed.

2. Due to the fact that the aggregates are wet and have absorbed water due to the rainy season, the input of water into the concrete mixer was carefully monitored to avoid watery concrete.

2. The revolution of the concrete mixer continues during the mixing and while transporting to the job site to ensure the inputs are thoroughly mixed before discharging at the job site.

3. Not too much of admixture was added to avoid long setting time of concrete.

Plate 3.53 Unicem cements labelled with their weight

3.6 TESTS CARRIED OUT ON CONCRETE SAMPLES

Concrete produced at the batching plant for the construction of the wall and base of the highway U-drain, as well as the construction of the slab of Trailer Park are tested for the purpose of quality control through the below:

1. Slump test

2. Concrete Cube test

Plate 3.54 Higway Drainage (Rehinforced Concrete)

Plate 3.55 Concrete slab of Trailer Park site

3.6.1 Slump Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. The test is conducted to check the consistency of freshly mixed concrete in a specific batch. Consistency refers to the ease and homogeneity with which the concrete can be mixed, placed, compacted and finished.

3.6.1.1 Apparatus needed

The apparatus includes the following; Slump cone in a clean and good condition, Tamping rod, flat metal plate and Meter tape.

3.6.1.2 Test Procedures

1. Obtained concrete sample was brought to the laboratory through a wheelbarrow.
2. The slump cone was dampened and placed on a flat, moist, non-absorbent and rigid surface.
3. By standing on the foot pieces, the cone was held firmly in place.
4. Immediately, the cone was filled in three layers, each layer approximately one-third the volume of the cone.
5. Each layer was rodded with 25 strokes of the tamping rod, by uniformly distributing the strokes over the cross-section of each layer.
6. An excess of concrete was maintained above the top of the cone. After the top layer was rodded, the surface of the concrete was strucked off even with the top of the cone.
7. Excess spillage of concrete was removed from the base of the cone.
8. The slump cone was lifted slowly and vertically and carefully to secure a proper result.
9. The concrete was allowed to settle
10. The cone was inverted and placed on the metal plate beside the concrete and the tamping rod was placed across the inverted cone.
11. The amount of slump was measured from the center of the top of the concrete vertically upwards the cone.
12. The value was recorded to the nearest millimeters.

Plate 3.56 measurement of slump

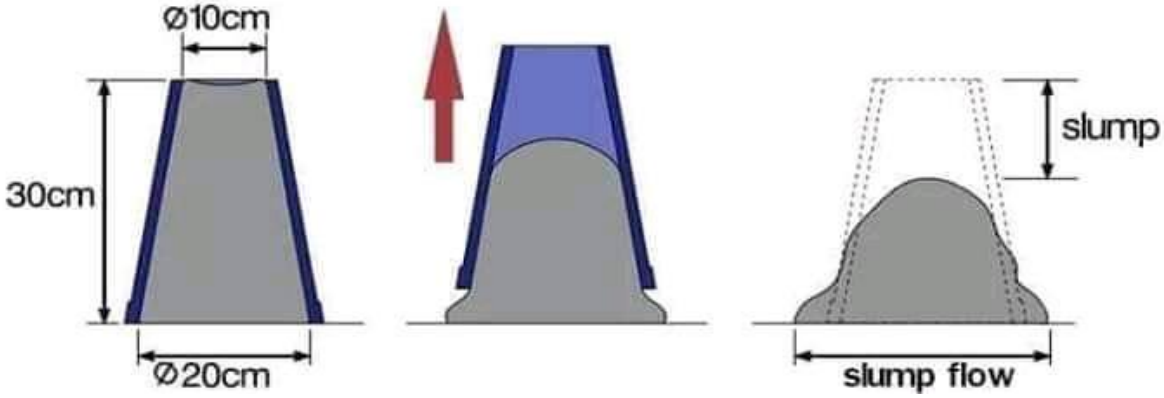


Figure 3.2 slump cone dimension and slump

3.6.1.3 Slump and workability

-Slump between 1 to 2 inches (25mm-50mm) means that the concrete mix has low workability.

-Slump between 2 to 4 inches indicates medium workability

-Slump greater than 4 inches indicates higher workability.

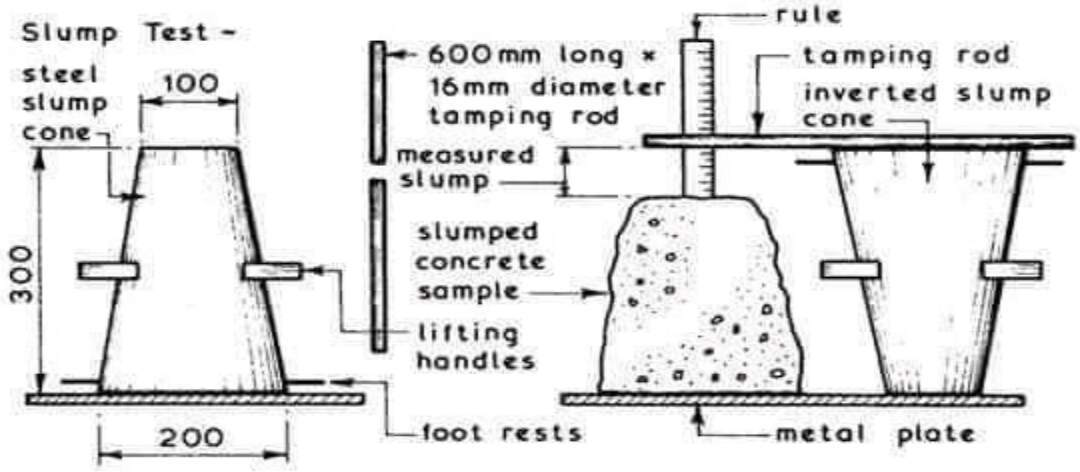


Figure 3.3 Slump measurement

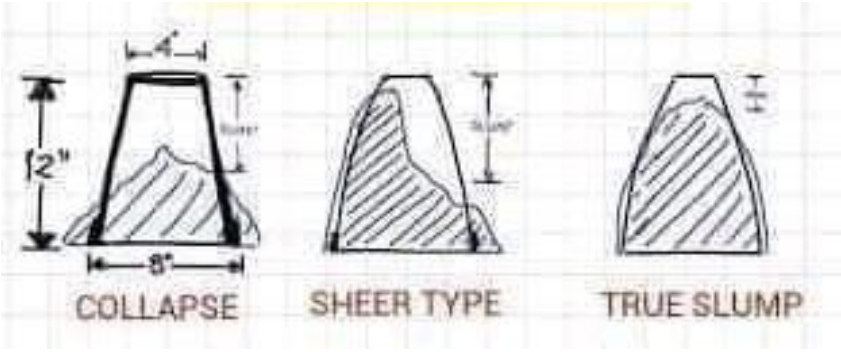


Figure 3.4 Types of Slump

1. True Slump**:** The concrete mass after the test when slumps evenly all around without disintegration is called the true slump.
2. Shear slump**:** when one half of concrete mass slide down the other is called the shear slump. This type of slump is obtained in a lean concrete.
3. Collapse slump**:** when the sample is collapsed due to adding excess water.

Table 3.2 Recommended Slumps of Concrete

No	**Types of concrete**	**Slump**
1	Concrete for road construction	20mm to 40mm
2	Concrete for tops of curbs, parapets, piers, slabs and walls that are horizontal	40mm to 50mm
3	Concrete for canal linings	70mm to 80mm
4	Concrete for arch and side walls of tunnels	90mm to 100mm
5	Normal R.C.C. work	80mm to150mm

3.6.2 Concrete Cube Test

Concrete cube test measures the compressible cube strength of the concrete and relates directly to the required design strength specified. Also it is a minimum requirement from the client to provide evidence of cube test results to ensure compliance with designs requirements.

3.6.2.1 Objective:

To determine the compressive strength value of concrete cubes.

3.6.2.2 Apparatus:

Cube mould (150mm), Electronic Weighing Balance,Wheelbarrow, Tamping rod, Slump cone, Scoop, Trowel, Measuring tape, Concrete curing tanks and the Compression testing machine.

3.6.2.3 Procedures:

1. Slump Test was carried out on the concrete to be casted.

2. Thoroughly mixed the dry ingredients to obtain the uniform mixture.

3. The moulds are lightly coated with engine oil to ensure the concrete does not stick to the mould and makes it easier to remove the mould.

4. The concrete sample was scooped into the six moulds in three equal layers

5. Thirty-five tamps were given to each layer using the tamping rod. Tamping compacts and removes the trapped air in the concrete.

Plate 3.57 Cube casting

6 The concrete mould is vibrated manually after tamping each layer.

7. A trowel was used to give a smooth surface flush with the top of the mould.

Six concrete cubes were casted from each sample of concrete gotten from the batching plant.

8. The cubes were left for 16hours or 24hours maximum; for hardening.

9. The cube moulds were loosened using spanners of both flat and ring, and then immediately coupled back.

10. Concrete fragments were scrapped off the cube moulds using a scrapper

Plate 3.58 Cube Demoulding and Cured

11. These cubes were labelled with the date of casting, cube serial number (code), number of curing days and the date of testing.

12. The cubes were moved into the concrete curing tank for curing. Three cubes were cured for 7 days while three other cubes, casted from the same sample were cured for 28 days. The curing tanks operate at temperature between 20 ± 2 ºC and provides a moist environment that allows the cube to hydrate properly.

13. On the due dates of testing, at 7 0r 28 days; the cubes are removed from the curing tank, dried.

14. The weight of each cube was taken using the weigh balance, and brought to the compression machine.

15. Each cube was placed into the compression machine centrally. The cubes were correctly placed on the machine plate by checking the circular markings on the plate and carefully aligning the cubes with the spherically seated plate.

16. The load was applied axially as the Pro Controller was started. The compression machine exerts a constant progressive force on the cubes, till they fail.

17. The readings at failure were noted for each cube. This value in Kilonewton is taken to be the maximum compressive strength of the cubes.

18. The appearance of the cubes and any unusual feature in the type of failure was also noted.

19. The results were recorded.

20. The tested cubes were disposed.

Plate 3.59 Concrete cube test

3.6.2.4 Precautions:

1 Over vibration was avoided as it may lead to segregation or disruption of the concrete mix.

2 little oil was used as a mould removal agent to avoid Darkening of the cubes after removal.

3 Multiple loosening of concrete cubes were avoided to ensure no bolts or nuts is interchanged or misplaced.

4 It was ensured that the bolts and nuts of the moulds were firmly tightened.

4 The cubes were correctly labelled, before transferring into the curing tank.

5 The cubes were at all times submerged in the curing tank.

6 The cubes were removed from the water at least 30minutes and kept in a dry condition before conducting the test.

7. The curing water were renewed every seven days.

3.6.2.5 Calculations:

THREE CONCRETE CUBES TESTED AT 7 DAYS

Mass of each concrete cubes= 8334g, 8335g, 8339g

Volume of each concrete cube = 15cm × 15cm × 15cm

$= 3375cm^3$

Density of cube = Mass of cube/Volume of cube

Density of cubes = = $\frac{8330}{3375}$, $\frac{8353}{3375}$,$\frac{8341}{3375}$

Density of cubes = $2.468g/cm^3$, $2.475g/cm^3$, $2.471g/cm^3$

Maximum Load at failure 490KN, 450KN, 440KN

Cross sectional area of the cube = 150mm × 150mm = $22500mm^2$

Compressive strength of concrete = Maximum load / cross sectional area

$= \frac{490000}{22500}$,$\frac{450000}{22500}$,$\frac{440000}{22500}$

$= 21.8\ KN/mm^2, 20.0\ KN/mm^2$, $19.6\ KN/mm^2$

Average of the three values shall be taken as the representative of the batch.

Average Compressive strength = $\frac{21.8 + 20.0 + 19.6}{3}$ = $\frac{61.4}{3}$

$= 20.4\ KN/mm^2$

One concrete cube must have strength within the limits of ±15% of the average value,

Otherwise, the result will be invalid.

Table 3.3 Concrete Strength over time

Days after Casting	**Strength Gain**
Day 1	16%
Day 3	40%
Day 7	65%
Day 14	90%
Day 28	99%

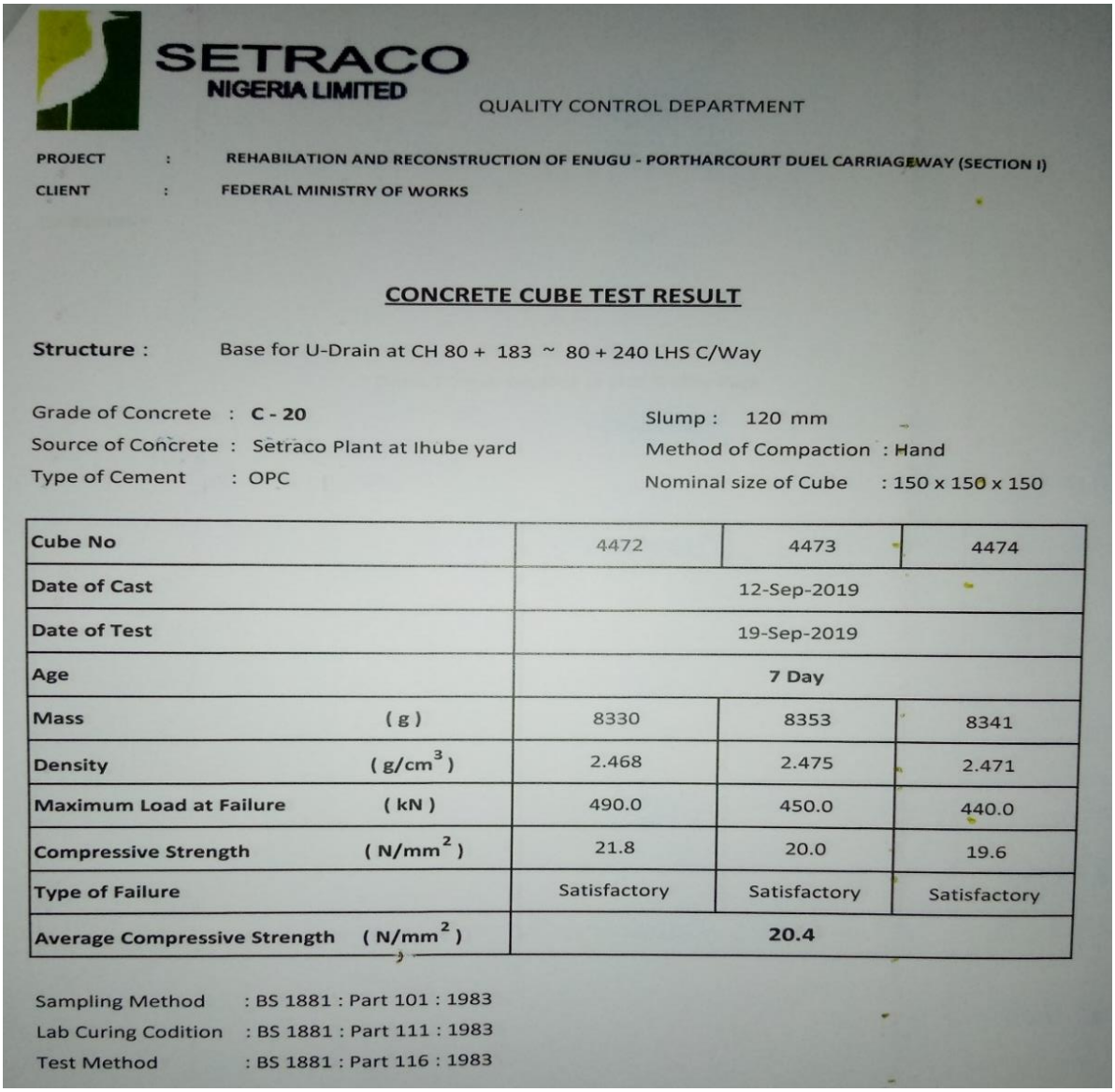
Table 3.4 Compressive Strength Table Of Concrete At 7 And 28 Days

Grade of Concrete	**Minimum compressive strength (N/mm^2)at 7 days**	**Minimum compressive strength (N/mm^2)at 28 days**
C15	10	15
C20	13.5	20
C25	17	25
C30	20	30
C35	23.5	35
C40	27	40
C45	30	45

3.6.2.6 Durability of Concrete:

Cube testing alone is not the criteria for the durability of concrete structure. A durable concrete is one that performs satisfactory in the working environment during its anticipated exposure condtions during service. It is essential that every concrete structure should continue to perform its intended functions, that is maintained its required strength and serviceability, during the specified or traditionally expected service life. It follows that concrete must be able to withstand the processes of deteriotation to which it can be expected to be exposed. Such concrete is said to be durable.

3..6.2.7 Test form:



SETRACO
NIGERIA LIMITED
QUALITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUEL CARRIAGEWAY (SECTION I)
CLIENT : FEDERAL MINISTRY OF WORKS

CONCRETE CUBE TEST RESULT

Structure : Base for U-Drain at CH 80 + 183 ~ 80 + 240 LHS C/Way

Grade of Concrete : **C - 20**
Source of Concrete : Setraco Plant at Ihube yard
Type of Cement : OPC

Slump : 120 mm
Method of Compaction : Hand
Nominal size of Cube : 150 x 150 x 150

Cube No		4472	4473	4474
Date of Cast		12-Sep-2019		
Date of Test		19-Sep-2019		
Age		**7 Day**		
Mass	(g)	8330	8353	8341
Density	(g/cm^3)	2.468	2.475	2.471
Maximum Load at Failure	(kN)	490.0	450.0	440.0
Compressive Strength	(N/mm^2)	21.8	20.0	19.6
Type of Failure		Satisfactory	Satisfactory	Satisfactory
Average Compressive Strength	(N/mm^2)	**20.4**		

Sampling Method : BS 1881 : Part 101 : 1983
Lab Curing Codition : BS 1881 : Part 111 : 1983
Test Method : BS 1881 : Part 116 : 1983

Plate 3.60 showing concrete cube test result

3.7 TESTS ON SUBGRADE MATERIALS (MILLED ASPHALT WITH LATERITE)

The subgrade layer of the highway is the foundation of the pavement structure, on which sub-base is laid on. Subgrade is commonly compacted before the construction of a road. The existing highway pavement serves the purpose of a natural subgrade. Laterite material was applied to the surface of the existing road and then milled using Milled Asphalt material. The various tests conducted on the sub-grade materials includes: Sieve Analysis, Liquid Limit and Plastic Limit Test, California Bearing Ratio Test and Compaction Test.

Plate 3.61 Milling of the road site as subgrade layer

3.7.1 Liquid Limit, Plastic Limit and Plastic Index Test

Liquid limit, plastic limit, along with shrinkage limit are referred to as the "Atterberg limits", after the originator of the test procedures.

The liquid limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dried soil, at the boundary between the liquid and plastic states of consistency. The moisture content at this boundary is arbitrarily defined as the water content at which two halves of a soil cake will flow together.

The plastic limit of a soil is the moisture content, expressed as a percentage of the weight of the oven-dry soil, at the boundary between the plastic and semisolid states of consistency. It is the moisture content at which a soil will just begin to crumble when rolled into a thread ⅛ in. (3 mm) in diameter using a ground glass plate or other acceptable surface.

The plasticity index of a soil is the numerical difference between its liquid limit and its plastic limit, and is a dimensionless number. Both the liquid and plastic limits are moisture contents.

3.7.1.1 Objective: To determine the liquid limit, plastic limit and plastic index of a soil sample (laterite and milled asphalt)

3.7.1.2 Apparatus: mortar and pestle, sieve size 0.425mm, spatula, sensitive balance, water bottle, metal cans, Electrical Liquid limit device, glass plate, Oven and grooving tool.

3.7.1.3 Procedures:

1. The soil was thoroughly dried in an oven.

2. The brittle particles of the soil sample was pulverized using pestle and mortar, in order to break and release fines.

3. Sieve No. 40 (0.425 mm) was then utilized, the material retained on the No. 40 (0.425 mm) sieve was discarded. The material passing the No. 40 (0.425 mm) sieve obtained from the grinding and sieving operations described was thoroughly mixed together and set aside for use in performing the physical tests.

4. Each labelled metal can was weighed using the sensitive balance and the weights were recorded.

5. The soil sample prepared was then thoroughly mixed with the addition of distilled, demineralized or tap water by alternately and repeatedly stirring, cutting and kneading with a spatula.

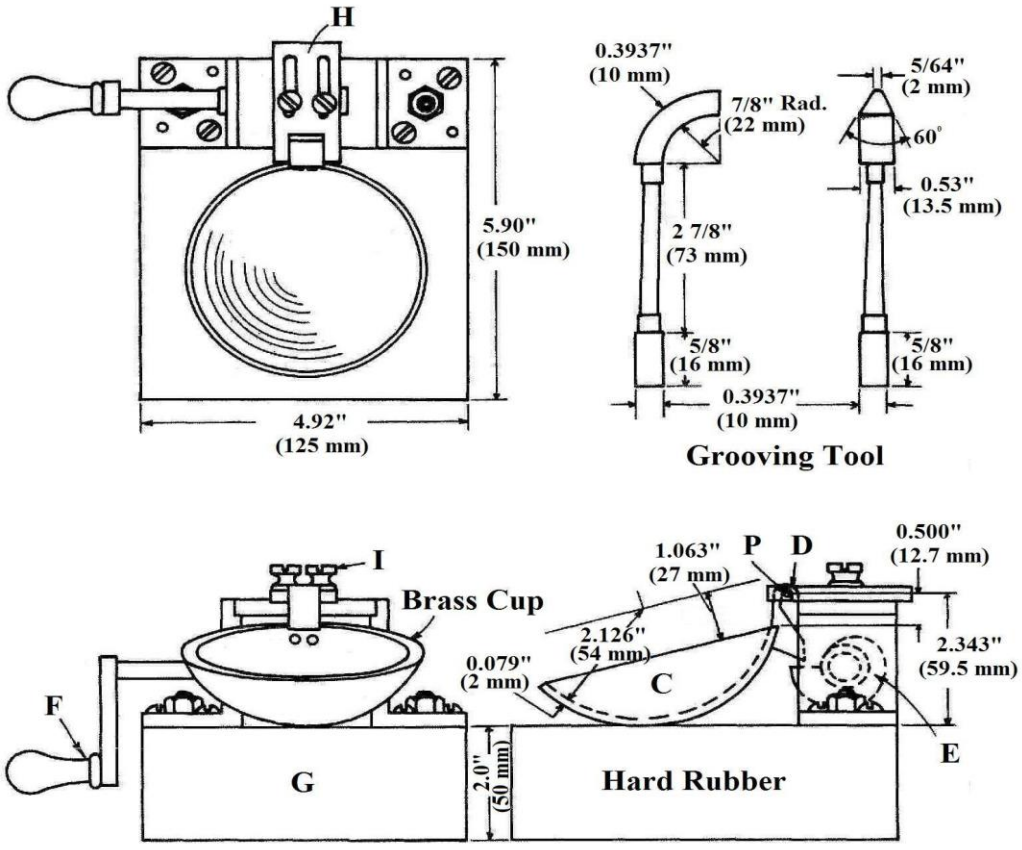


Figure 3.5 showing the liquid limit device

6. Sufficient quantity of the soil mixture was placed in the cup and was squeezed and spread into the position with strokes of the spatula.

7. With the spatula, the level of the soil was trimmed to a depth of 10 mm at the point of maximum thickness.

8. The soil in the cup was divided equally by a firm stroke of the grooving tool along the diameter through the centerline of the cam follower so that a clean, sharp groove of the proper dimensions was formed.

9. The liquid limit device was tarred and put on. The device automatically Lift and drop the cups, until the two halves of the sample flow together and come in contact at the bottom of the groove. Some soils tend to slide on the surface of the cup, at a lesser number of blows, instead of flowing. When this occurred, the sample was remixed and repeated.

Plate 3.62 The soil sample before and after sliding and the number of blows

10. The number of drops (blows) required to close the groove this distance was recorded.

11. A sample of the soil was now taken to determine its moisture content. A slice of soil approximately the width of the spatula, extending from edge to edge of the soil cake at right angles to the groove and including that portion of the groove in which the soil flowed together and then weighed and recorded.

12. The soil remaining in the cup was transferred to the mixing dish. The cup and grooving tool was then washed and dried in preparation for the next trial.

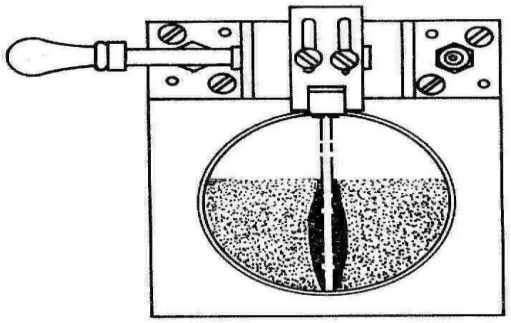
13. Procedures 4 to 11 above, was repeated for three more trials.

14. Already weighed wet Slices of soil from procedure 10 above, was oven dried and the weight of the dried sample was taken.

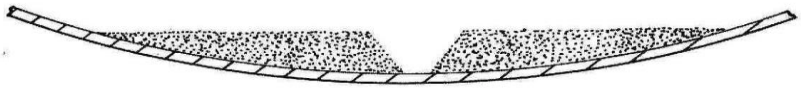
15. There are certain circumstances under which the plasticity index cannot be determined.

(a). When either the liquid limit or plastic limit cannot be determined, report the plasticity index as NP (non-plastic).
(b). When the soil is extremely sandy, the plastic limit test shall be done before the liquid limit test. If the plastic limit cannot be determined, then report the plasticity index as NP (non-plastic).

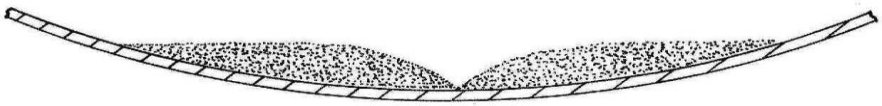
(c). When the plastic limit is equal to or greater than the liquid limit, report the plasticity index as NP (non-plastic).



Liquid Limit Device with Soil Sample in Place



Divided Soil Cake Before Test



Soil Cake After Test

Figure 3.6 Illustrating Liquid Limit Test

3.7.1.4 Calculations:

Moisture (g) = (Wet soil + container) – (dry soil + container)

Weight of dry soil (g) = (Dry soil + container) – weight of container

Moisture content = (Moisture/weight of dry soil) ×100

Liquid limit (%) = Average moisture content of the liquid limit

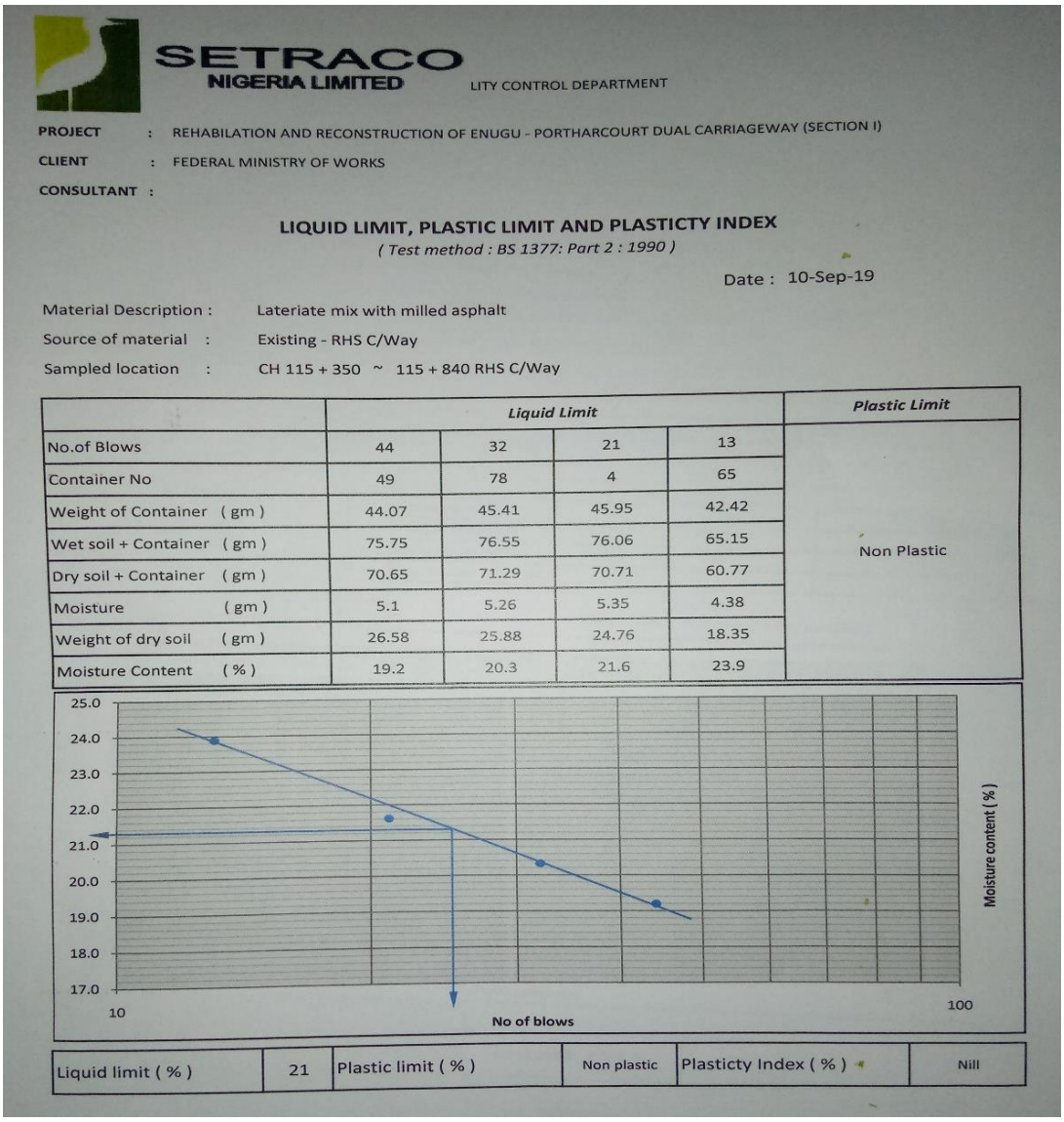
Plastic limit (%) = Average moisture content of the plastic limit

Plasticity Index (%) = Liquid Limit (%) - Plastic Limit (%)

Table 3.5 The expected number of blows for each trial for liquid limit test

Trials	**Expected number of blows**
first	40-50
second	30-39
third	20-25
forth	10-19

3.7.1.5 Test form:



SETRACO NIGERIA LIMITED — LITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUAL CARRIAGEWAY (SECTION I)

CLIENT : FEDERAL MINISTRY OF WORKS

CONSULTANT :

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICTY INDEX

(Test method : BS 1377: Part 2 : 1990)

Date : 10-Sep-19

Material Description : Lateriate mix with milled asphalt

Source of material : Existing - RHS C/Way

Sampled location : CH 115 + 350 ~ 115 + 840 RHS C/Way

	Liquid Limit				Plastic Limit
No.of Blows	44	32	21	13	
Container No	49	78	4	65	
Weight of Container (gm)	44.07	45.41	45.95	42.42	
Wet soil + Container (gm)	75.75	76.55	76.06	65.15	Non Plastic
Dry soil + Container (gm)	70.65	71.29	70.71	60.77	
Moisture (gm)	5.1	5.26	5.35	4.38	
Weight of dry soil (gm)	26.58	25.88	24.76	18.35	
Moisture Content (%)	19.2	20.3	21.6	23.9	

Liquid limit (%)	21	Plastic limit (%)	Non plastic	Plasticty Index (%)	Nill

Plate 3.63 Liquid limit test form

3.8 QUALITY CONTROL OF SUB-BASE COURSE MATERIALS (SAND-CEMENT)

The layer between the base course and the subgrade. The highway sub-base course materials are sand mixed with cement. The quality control of the sub-base involves the following tests such as Sieve Analysis of the sand, Compaction Test, California Bearing ratio Test, Unconfined Compression Test, Specific gravity and Water absorption Test and In-situ Dry Density Test (which are carried out simultaneously on the same soil sample. The properties of a soil can be improved by changing mechanical or chemical it or mixing it either with another soil or with cement, lime and bitumen (Terrel et al., 1979). One of the common stabilisation practices is Cement stabilisation

which can be used in different road construction applications such as subgrades, select fill, base and sub base (Wilmot, 2006).

Plate 3.64 Sub base stabilization using cement

3.8.1 Compaction (Standard Proctor) Test

Compaction test is a type of mechanical stabilization where the soil mass is densified with the application of mechanical energy also known as compactive effort. During compaction, the soil particles are relocated, and the air volume is reduced. The fundamentals of compaction test were first time presented by R.R. Proctor in 1993, in his honor; the standard laboratory compaction test which is developed is commonly called the standard Proctor Test. According to Proctor, the compaction of a soil mass is dependent of the following; Soil type, Moisture Content, Compactive effort and the dry density of the soil.

3.8.1.1 Objectives: To determine the Optimum moisture content and maximum dry density of a sub-base Sand cement sample.

3.8.1.2 Apparatus: Cylindrical metal mould, rammer (2.5kg), Sensitive balance, Speedy Moisture Checker, Tray, Scoop, Mallet, Mixing tools (trowel, spatula).

3.8.1.3 Procedures:

1. Sufficient quantity of the sand–cement sample was mixed thoroughly.

2. 5000kg of the sand-cement sample was weighed and the moisture content was checked using the speedy moisture content checker. It was ensured that the initial moisture content of the sample was at a minimum of 10%. Thus to attain this, the sample was surface dried or moisturize accordingly, as the case may be.

3. The compaction mould was set up and weighed (without the collar) on the weigh balance.

4. The collar was fixed and the sample was compacted in three equal layers by the rammer with evenly distributed lows to each layer.

Plate 3.65 The compaction processes

5. The collar was removed from the mould and the excess soil was trimmed off using spatula. Now, the mould plus the compacted soil was weighed. And the moisture content of the soil was checked and recorded using the speedy moisture checker.

6. The soil was removed from the mould using a mallet and mixed with the remaining soil in the tray. Using formulae *, the moisture content was increased by 2% through the addition of water.

7. Procedures 4, 5 and 6 were given 4 trials.

3.8.1.3 Calculation:

Formulae *, Water = (5000 – 20) × 2%

Formulae * for second trial, Water= (5000 – 40) × 2%

Formulae * for third trial, Water= (5000 – 60) × 2%

Formulae * for fourth trial, Water= (5000 – 80) × 2%

Weight density = Weight of soil/volume of mould

(Weight of container + wet soil) – (Weight of container + dry soil) = Weight of water

Weight of dry soil = (Weight of dry soil + Container) – weight of container

Moisture content = Weight of water / weight of dry soil

Dry density = (Weight density / (100 + moisture content)) × 100

Volume of mould = 1000 kg/cm^3

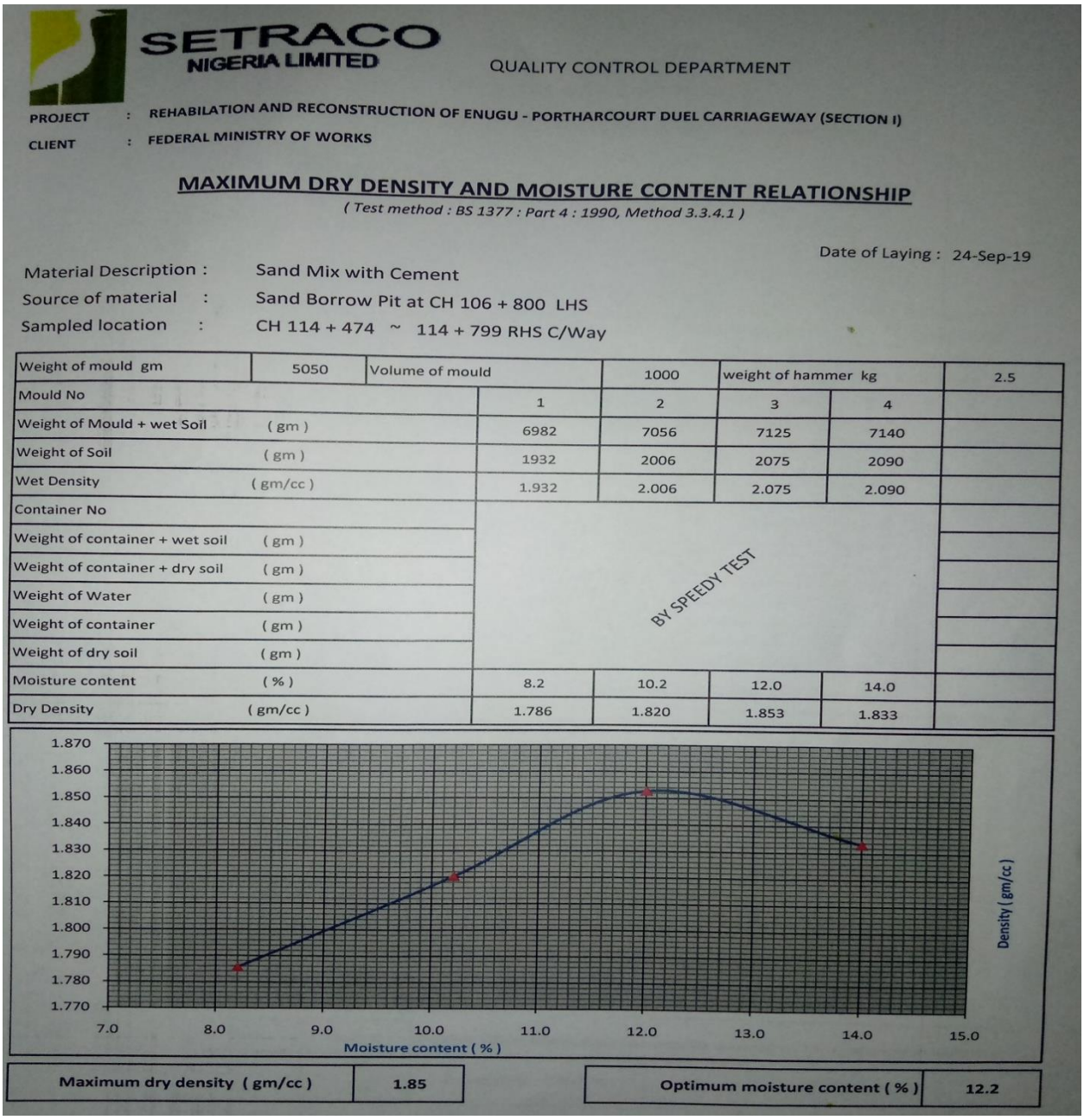
Weight of mould = 5050 grams

Weight of rammer = 2.5 kilograms

The graph of **Dry density** (gram/cm^3) against **Moisture content** (%) is plotted.

The particular value of moisture content at which the maximum dry density of a sample is attained, is known as the **Optimum moisture content (OMC).**

3.8.1.4 Test form:



SETRACO NIGERIA LIMITED

QUALITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUEL CARRIAGEWAY (SECTION I)

CLIENT : FEDERAL MINISTRY OF WORKS

MAXIMUM DRY DENSITY AND MOISTURE CONTENT RELATIONSHIP

(Test method : BS 1377 : Part 4 : 1990, Method 3.3.4.1)

Date of Laying : 24-Sep-19

Material Description : Sand Mix with Cement

Source of material : Sand Borrow Pit at CH 106 + 800 LHS

Sampled location : CH 114 + 474 ~ 114 + 799 RHS C/Way

Weight of mould gm	5050	Volume of mould		1000	weight of hammer kg	2.5
Mould No		1	2	3	4	
Weight of Mould + wet Soil	(gm)	6982	7056	7125	7140	
Weight of Soil	(gm)	1932	2006	2075	2090	
Wet Density	(gm/cc)	1.932	2.006	2.075	2.090	
Container No		BY SPEEDY TEST				
Weight of container + wet soil	(gm)					
Weight of container + dry soil	(gm)					
Weight of Water	(gm)					
Weight of container	(gm)					
Weight of dry soil	(gm)					
Moisture content	(%)	8.2	10.2	12.0	14.0	
Dry Density	(gm/cc)	1.786	1.820	1.853	1.833	

Maximum dry density (gm/cc)	1.85	Optimum moisture content (%)	12.2

Plate 3.66 Compaction Test Result

3.8.2 CALIFORNIA BEARING RATIO TEST (CBR TEST)

The California bearing ratio test is a measure of resistance of a material to penetration of a standard plunger, under controlled density and moisture conditions. It is a penetration test meant for the evaluating the strength of the sub-base material. It was developed by the California Division of Highways as a method of classifying and evaluating subgrade, sub-base and base course materials for flexible pavement.

3.8.2.1 Apparatus: Weigh balance, Surcharge loads, CBR mould set, C-spanner, Rammer, Spatula,

3.8.2.2 Procedures:

1. The sample of sand – cement was mixed thoroughly, and up to 7000grams was weighed. The moisture content of the weighed sample was checked using the Speedy moisture checker. The moisture content was ensured to be at minimum of 10% before kick starting the processes, and this was by adding the required amount of water.

2. The selected CBR mould was weighed on the Weigh Balance.

3. The CBR mould was set up, as the collar was fixed to the mould.

4. And then the soil sample was compacted in the mould in 3 equal layers, each layer given 55 blows of the 2.6kg rammer.

5. The collar was removed from the mould and the excess soil was trimmed off using spatula. Now, the mould plus the compacted soil was weighed.

Plate 3.67 Showing CBR test

6. The CBR mould and the compacted soil were covered top and bottom using an unperforated cover and then kept in under a cool temperature for 3 days.

7. On the seventh day, the CBR mould was turn upside down and then the base unperforated cover was replaced with a perforated cover. Filter paper was positioned in between the perforated cover and the soil surface before screwing. An extended collar was attached to the CBR mould top as Surcharge weights of 2.5kg were added to the top of the specimen. Thus the mould assembly and weights were immersed into a tank of water and soaked for 96 hours before penetration testing.

8. After 24 hours, the specimen was removed from the tank of water and allowed to drain.

9. For the penetration test, the mould assembly with the surcharge weights were placed on the CBR machine. The piston was position to the center of of the top surface of the specimen. The loading at the following penetrations were recorded; 0, 0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75, 2.0, 2.25, 2.50…

10. Procedure 9 above was repeated for the bottom surface of the specimen.

11. The mould was detached completely from the CBR. About 20 to 50gram soil was extracted from top and bottom surfaces of the specimen for moisture content determination.

3.8.2.3 Calculations:

Weight of compacted sample, mould and base plate = **W1** (grams)

Weight of mould and base plate = **W2** (grams)

Weight of sample (**W3**) = **W1 – W2** (grams)

Volume of sample = **V** (cm

Unit wet weight = **W3/V** (grams/cm^3)

Unit dry Weight = ((Unit wet weight / (100 + Moisture Content) × 100))

Force = Penetration × Ring factor *0.0425

CBR value at 2.5mm = (Penetration × Ring factor *0.0425)/15

CBR value at 5.0mm = (Penetration × Ring factor *0.0425)/30

CBR values are usually calculated for penetration of 2.5mm and 5mm.

The highest value of the two is taken as the CBR value.

3.8.3 UNCONFINED COMPRESSION TEST

The unconfined Compressive strength is the load per unit area at which the cylindrical specimen of a cohesive soil falls in compression. The Unconfined compression test (UCT) is a simple laboratory testing method to assess the mechanical properties of rocks and fine-grained soils. It provides a measure of the undrained strength and stress-strain characteristics of the rock or soil.

3.8.3.1 Apparatus: Cylindrical Split mould, Weighing balance, Unconfined Compression Machine, Mallet, vernier calipers, meter rule, oven,

3.8.3.2 Procedures:

1. Two empty Cylindrical split mould were weighed separately.

2. Two plates containing the same quantity of the sand mixed with cement material up to 540gram was compacted in layers using mallet, into the Split mould.

3. The Compacted soil with the split mould was weighed.

4. Attached to the two ends of the specimens were filter papers, which was covered with wax.

5. The two specimens were kept for six days. On the seventh day, the two specimens were removed from the split moulds and weighed. The length and diameter of the specimen were also measured using ruler and vernier caliper respectively.

6. One of the specimen was soaked for twenty-four hours, while the other was kept dry.

7. The soaked specimen was placed on the bottom plate of the UC machine. The upper plate was adjusted to make contact with the specimen.

Plate 3.68 Compaction of soil-cement sample into the split mould

8. The compression load was applied to cause axial strain at the rate of 0.5 to 2% per minute. The load and deformation values were recorded until failure surfaces.

Plate 3.69 Compression load being applied

9. The moisture content of the specimen was then determined through oven drying.

10. Procedures 7 to 9 were repeated for the unsoaked specimen.

3.8.3.3 Calculations:

Diameter of Specimen = **d** (mm)

Length of specimen = l̨ (mm)

Mass of Specimen = **m** (grams)

Area of Specimen = **Å** (mm^2)

Volume of Specimen (**V**) = **A**× l̨ (cm^3)

Density of Specimen = **m/V** ($gram/cm^3$)

Compression of specimen = change in length **L** (mm)

Strain (ε) = L/l̥

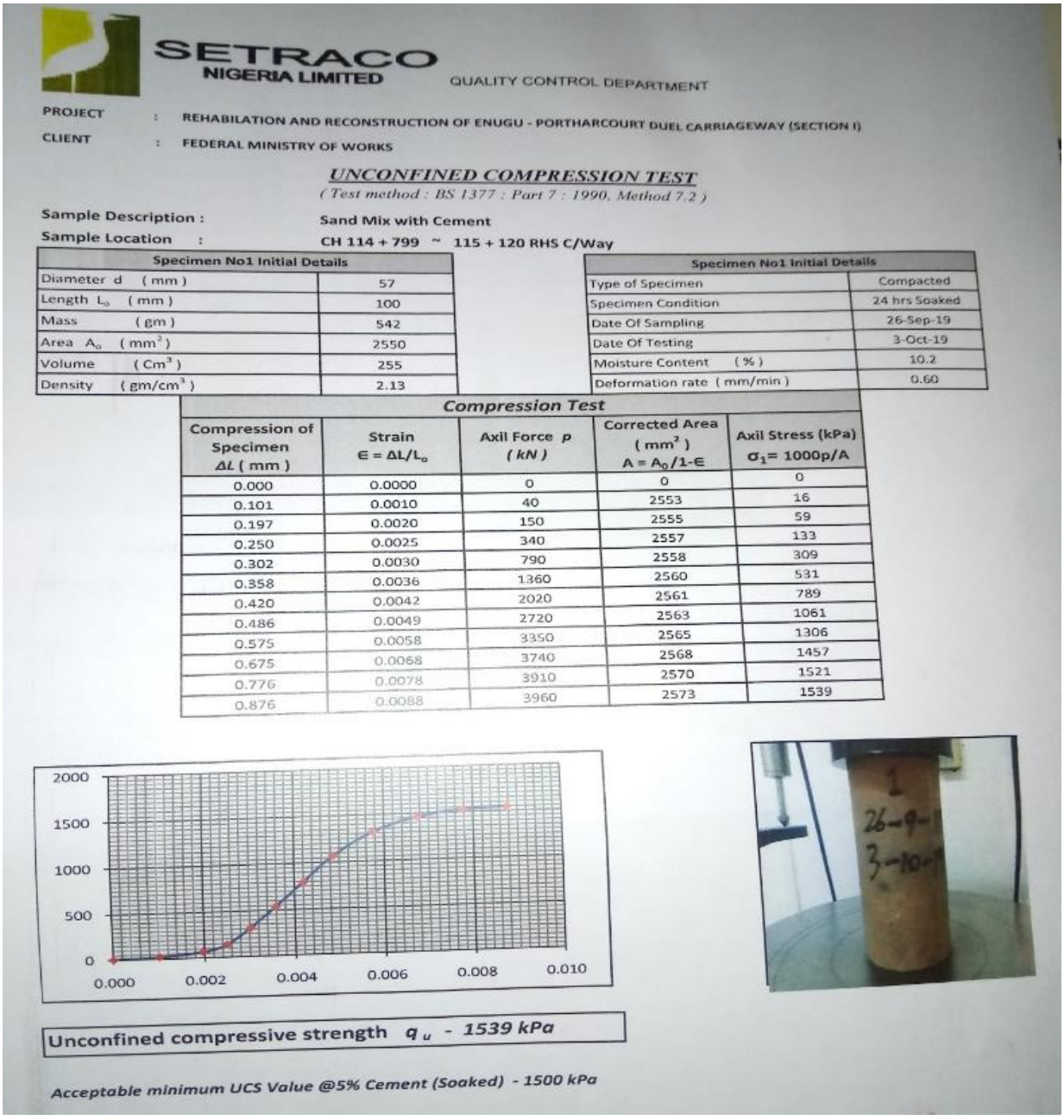
Axial force = **ρ** (KN)

Corrected Area (**A**) = **Å/1 - ε** (mm^2)

Axial stress σ_1 = 1000ρ/A (Kilopascal)

The graph of **Axial stress** against **Strain** is plotted and the peak of the curve is taken as the **Unconfined Compressive strength** of each specimen.

3.8.3.4 Result:



SETRACO NIGERIA LIMITED — QUALITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUEL CARRIAGEWAY (SECTION I)

CLIENT : FEDERAL MINISTRY OF WORKS

UNCONFINED COMPRESSION TEST

(Test method : BS 1377 : Part 7 : 1990, Method 7.2)

Sample Description : Sand Mix with Cement

Sample Location : CH 114 + 799 ~ 115 + 120 RHS C/Way

Specimen No1 Initial Details	
Diameter d (mm)	57
Length L_o (mm)	100
Mass (gm)	542
Area A_o (mm^2)	2550
Volume (Cm^3)	255
Density (gm/cm^3)	2.13

Specimen No1 Initial Details	
Type of Specimen	Compacted
Specimen Condition	24 hrs Soaked
Date Of Sampling	26-Sep-19
Date Of Testing	3-Oct-19
Moisture Content (%)	10.2
Deformation rate (mm/min)	0.60

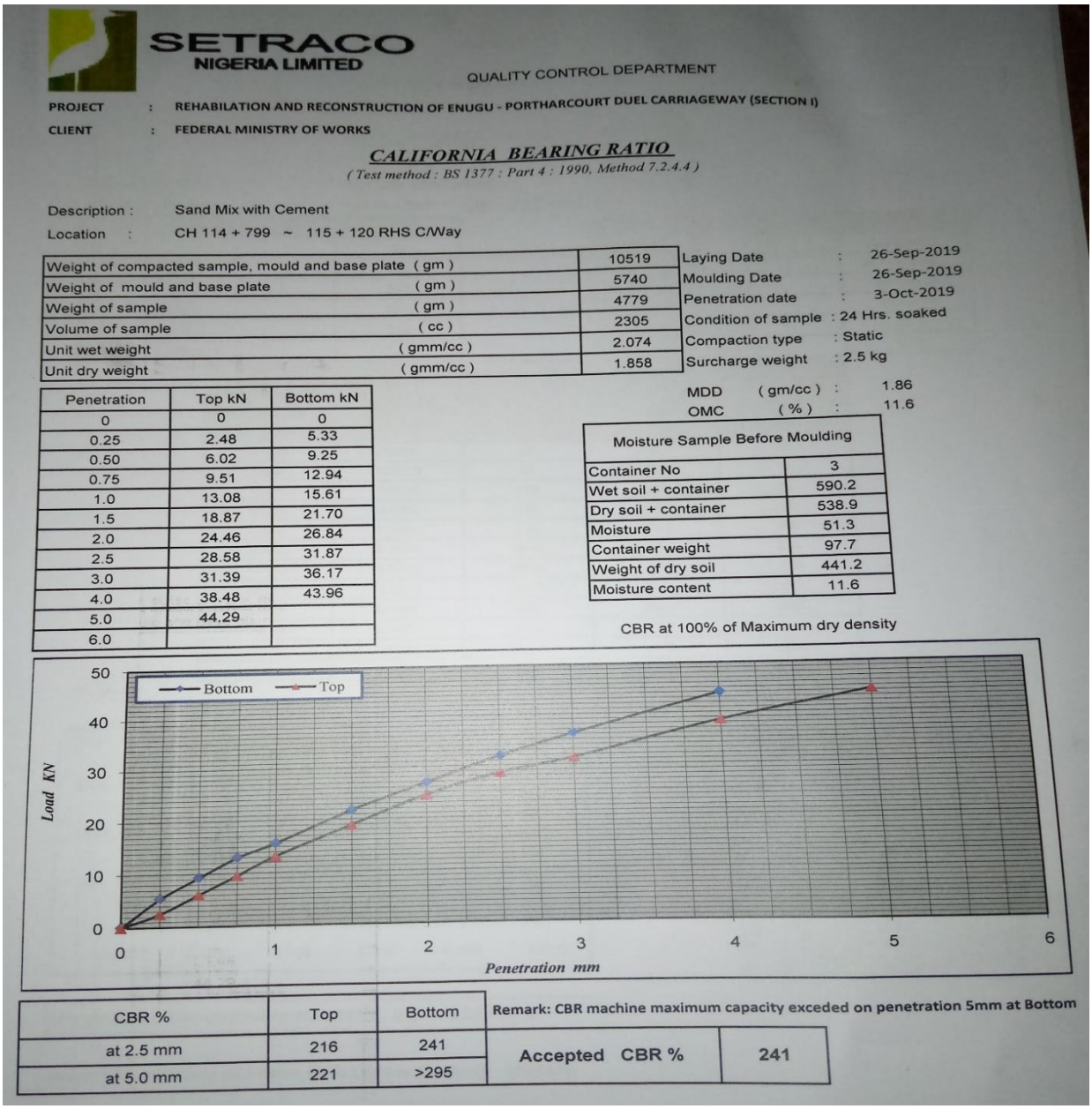
Compression Test

Compression of Specimen ΔL (mm)	Strain ∈ = ΔL/L_o	Axil Force p (kN)	Corrected Area (mm^2) A = A_0/1-∈	Axil Stress (kPa) σ_1= 1000p/A
0.000	0.0000	0	0	0
0.101	0.0010	40	2553	16
0.197	0.0020	150	2555	59
0.250	0.0025	340	2557	133
0.302	0.0030	790	2558	309
0.358	0.0036	1360	2560	531
0.420	0.0042	2020	2561	789
0.486	0.0049	2720	2563	1061
0.575	0.0058	3350	2565	1306
0.675	0.0068	3740	2568	1457
0.776	0.0078	3910	2570	1521
0.876	0.0088	3960	2573	1539

Unconfined compressive strength q_u - 1539 kPa

Acceptable minimum UCS Value @5% Cement (Soaked) - 1500 kPa

Plate 3.70 Unconfined Compression Test form



SETRACO NIGERIA LIMITED

QUALITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUEL CARRIAGEWAY (SECTION I)

CLIENT : FEDERAL MINISTRY OF WORKS

CALIFORNIA BEARING RATIO

(Test method : BS 1377 : Part 4 : 1990, Method 7.2.4.4)

Description : Sand Mix with Cement

Location : CH 114 + 799 ~ 115 + 120 RHS C/Way

Weight of compacted sample, mould and base plate	(gm)	10519
Weight of mould and base plate	(gm)	5740
Weight of sample	(gm)	4779
Volume of sample	(cc)	2305
Unit wet weight	(gmm/cc)	2.074
Unit dry weight	(gmm/cc)	1.858

Laying Date : 26-Sep-2019
Moulding Date : 26-Sep-2019
Penetration date : 3-Oct-2019
Condition of sample : 24 Hrs. soaked
Compaction type : Static
Surcharge weight : 2.5 kg

MDD (gm/cc) : 1.86
OMC (%) : 11.6

Penetration	Top kN	Bottom kN
0	0	0
0.25	2.48	5.33
0.50	6.02	9.25
0.75	9.51	12.94
1.0	13.08	15.61
1.5	18.87	21.70
2.0	24.46	26.84
2.5	28.58	31.87
3.0	31.39	36.17
4.0	38.48	43.96
5.0	44.29	
6.0		

Moisture Sample Before Moulding	
Container No	3
Wet soil + container	590.2
Dry soil + container	538.9
Moisture	51.3
Container weight	97.7
Weight of dry soil	441.2
Moisture content	11.6

CBR at 100% of Maximum dry density

CBR %	Top	Bottom
at 2.5 mm	216	241
at 5.0 mm	221	>295

Remark: CBR machine maximum capacity exceded on penetration 5mm at Bottom

Accepted CBR % 241

Plate 3.71 California Bearing ratio test form

3.8.4 INSITY DENSITY TEST BY SAND REPLACEMENT METHOD

The field density of soil is conducted on the field to know whether the specified compaction is achieved or not. Normally, sand replacement method is adopted for this purpose. Sand replacement method is also known as sand cone method. Other methods includes core cutter method, rubber balloon method, heavy oil method etc.

3.8.4.1 Aim: To determine the field density by sand replacement method.

3.8.4.2 Apparatus: Sand cone apparatus, Density plate, Digging tools, Weigh balance, Spoon, brush, Speedy moisture tester, etc.

3.8.4.3 Procedures: The test is conducted in two stages:

1. Calibration of apparatus: Clean and dry sand passing through 1.0mm sieve and retained on 600 micron sieve was collected in sufficiency and used for the calibration. The unit weight of the sand is determined.

2. Measurement of field density: After the compaction of the sub-base (sand cement) level, a tray with a central hole is placed on the prepared ground surface and a hole of 100mm diameter and 150mm deep is excavated in the ground, using the hole in the tray as a pattern. The soil was carefully collected and weighed. The moisture content of the excavated soil was determined using the speedy moisture tester. The sand cone was filled with sand up to 10mm from the top and weighed. The sand filled cone was made to sit on the tray over the hole. The shutter was opened and the hole is filled with sand. As the sand stopped running out, the shutter is closed and the cone was weighed with the left over sand.

Plate 3.72 Digging a hole and sand replacement

3.8.4.3 Calculation

Weight of sand in hole = (weight of sand in hole + cone) – weight of sand in cone

Wet density (gram/cm^3) = weight of soil from the hole / volume of hole

Dry density (gram/cm^3) = (wet density/ (100 + moisture content)) ×100

% of maximum dry density = (dry density / Max. dry density) ×100

3.8.4.4 Precautions

1. Sand used in this test was dry and the calibration of the cone was done before commencing.

2. Sample collected for moisture content determination was kept covered.

Plate 3.73 Depth measurement

3.9 QUALITY CONTROL OF BASE COURSE MATERIALS (STONE BASE)

The base course of a flexible pavement is the layer immediately beneath the surface course. It provides additional load distribution and contributes to drainage. Base course are usually constructed pout of crushed aggregates. The various laboratory tests carried out on the stone base materials are similar to those carried out on the surface course materials, thus are discussed in the surface course quality control section. These tests are as highlighted in Table 3.1.

3.10 QUALITY CONTROL OF SURFACE COURSE MATERIALS (BINDER)

The layer in contact with traffic loads is referred to as the surface course. It provides characteristics such as friction and it prevents entrance of surface water into the underlying base, sub-base and subgrade (NAPA, 2001). This top structural layer of material is subdivided into two layers: **the wearing course (top) and binder course (bottom).**

The principal mechanical properties required in the surface course materials are:

1. Satisfactory resistance to crushing under roller during construction.
2. Adequate resistance to surface abrasion under traffic.

Aggregates used as base course and surface course materials, should be strong enough to resist crushing under traffic wheel loads. If the aggregates are weak, the stability of the pavement structure is likely to be adversely affected. The following tests are dicussed:

1. Aggregate Sieve Analysis
2. Los Angeles Abrasion Test
3. Aggregate Crushing Value
4. Elongation Index Test

5. Flakiness Index Test

6. Bulk density test

3.10.1 LOS ANGELES ABRASION TEST

The Los An geles Abrasion test is used widely as an indicator of aggregate quality.The test measures the degradation of standard gradings of aggreagtes subjected to abrasion and impact in a rotating steel drum containing of abrasive charge of steel balls.

3.10.1.1 Objective:

To test for the hardness property of aggregates. To test the percentage wear due to relative rubbing action between the aggregates and steel balls used as abrasive charges.

3.10.1.2 Apparatus:

weigh balance, set of sieves, Abrasive charges and the Los Angeles Testing machine

3.10.1.3 Procedures:

1. Sieve analysis of the aggregate sample.

2. The access cover to the LAA machine was loosened.

Plate 3.74 Abrasive charges with aggregate

3. The test sample and the abrasive charge (Eleven balls of 47mm) were poured into the Los Angeles abrasion testing machine.

4. The Access cover was bolted to enclose the specimen.

5. The machine rotation was set to 500 revolution using the electronic control unit.

6. The machine steel drum rolled at a speed of 31-33 r.p.m. and the automatic counter stops the machine when the preset 500 revolution was reached.

Plate 3.75 Automatic counter

7. The access cover was removed to unload the drum which allowed the discharged of the aggreagtes and abrasive charges using a tray as collector.

3.10.1.4 Calculations:

Weight of oven-dried sample is represented with **A**

Weight of

Aggregate Abrasion value = ((**A**-**B**)/**A**) X 100

Table 3.6 Aggregate Grading

Sieve Size		Weight in gm. of Test Sample for Grade						
Passing (mm)	Retained on (mm)	A	B	C	D	E	F	G
80	63					2500		
63	50					2500		
50	40					5000	5000	
40	25	1250					5000	5000
25	20	1250						5000
20	12.5	1250	2500					
12.5	10	1250	2500					
10	6.3			2500				
6.3	4.75			2500				
4.75	2.36				5000			

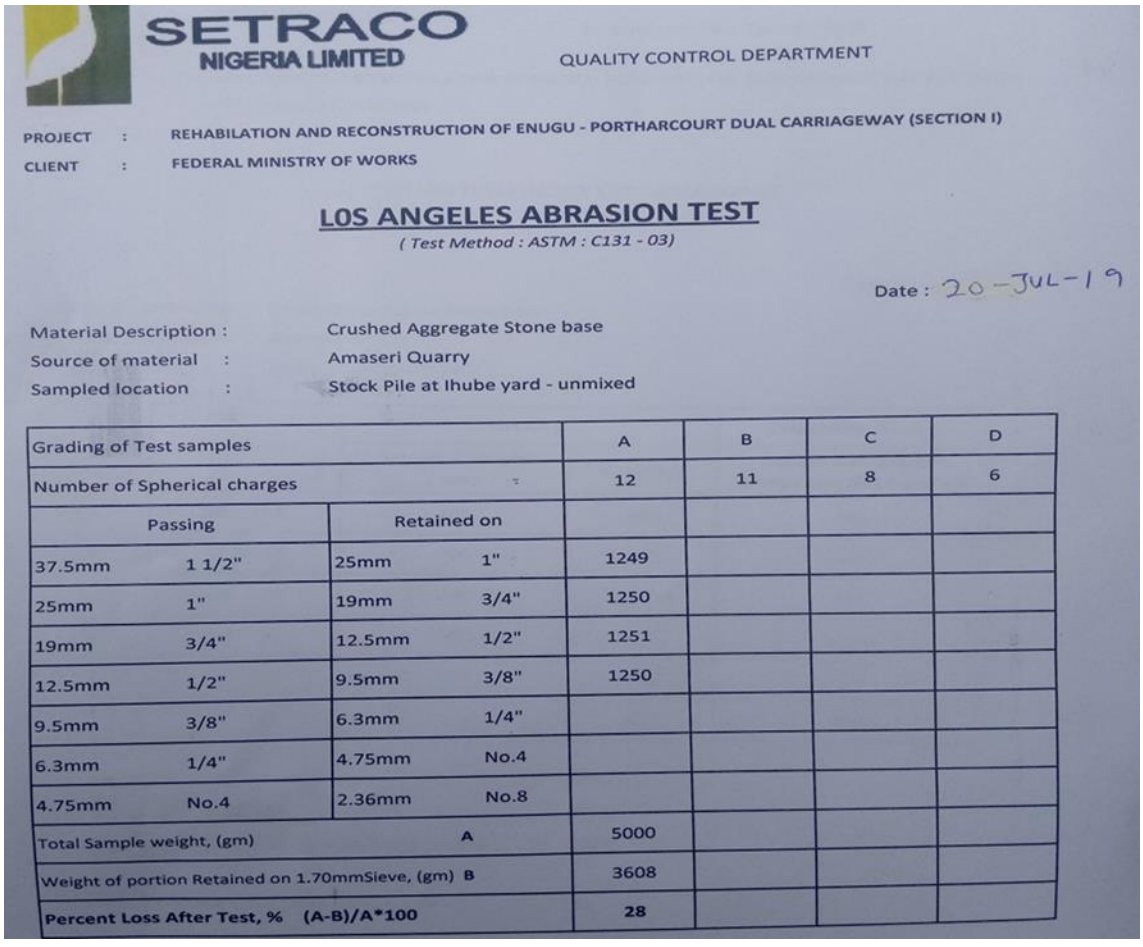
Table 3.7 Aggregate grading and number of charges

Grading	Number of spheres	Weight of charge (gm)
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15
E	12	5000 ± 25
F	12	5000 ± 25
G	12	5000 ± 25

Table 3.8 Permitted Abrasion Value

Sl. No.	Type of Pavement	Max. permissible abrasion value in %
1	Water bound macadam sub base course	60
2	WBM base course with bituminous surfacing	50
3	Bituminous bound macadam	50
4	WBM surfacing course	40
5	Bituminous penetration macadam	40
6	Bituminous surface dressing, cement concrete surface course	35
7	Bituminous concrete surface course	30

3.10.1.5 L.A. Test form



SETRACO NIGERIA LIMITED

QUALITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUAL CARRIAGEWAY (SECTION I)

CLIENT : FEDERAL MINISTRY OF WORKS

LOS ANGELES ABRASION TEST

(Test Method : ASTM : C131 - 03)

Date : 20-JUL-19

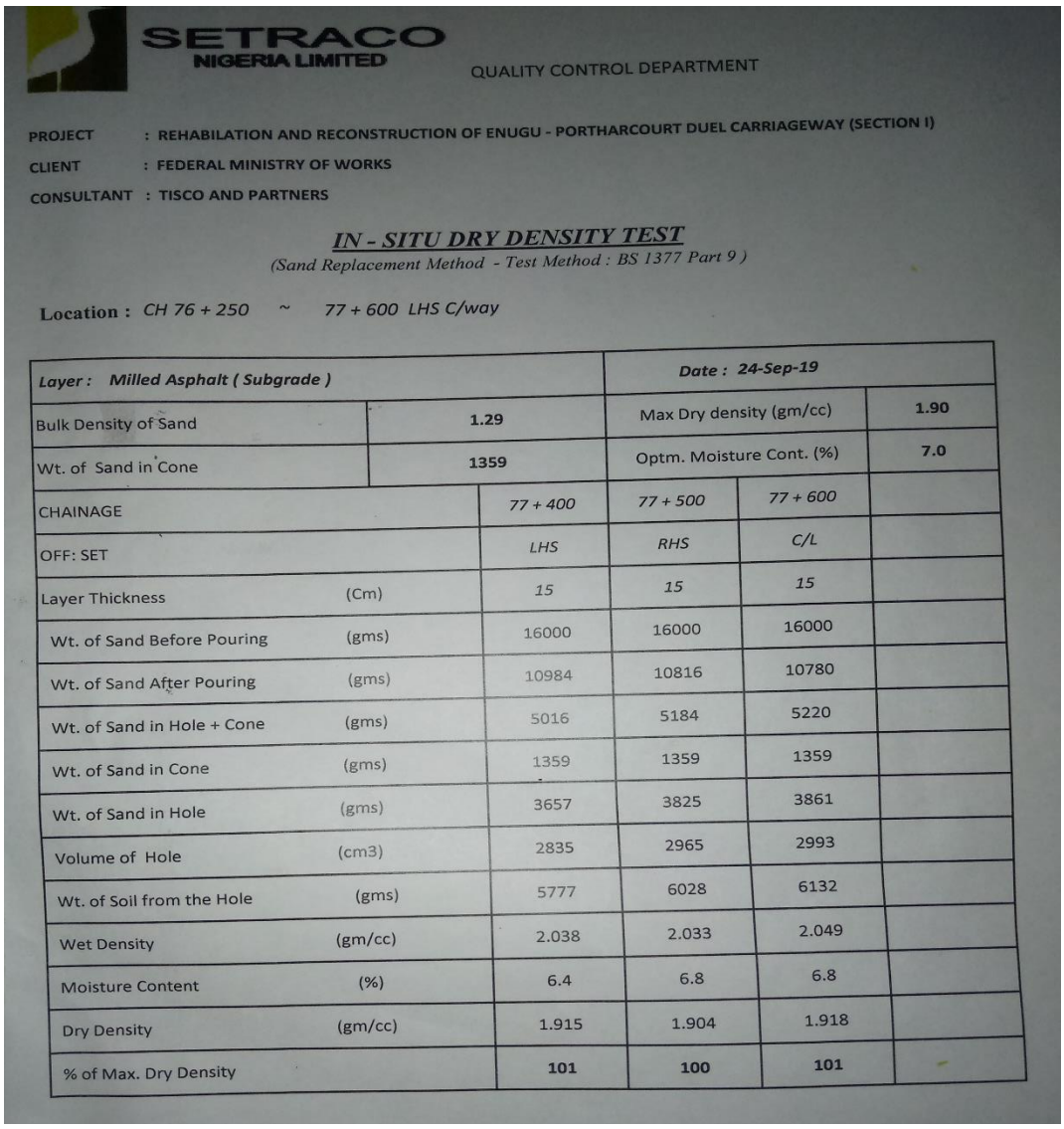
Material Description : Crushed Aggregate Stone base

Source of material : Amaseri Quarry

Sampled location : Stock Pile at Ihube yard - unmixed

Grading of Test samples				A	B	C	D
Number of Spherical charges				12	11	8	6
Passing		Retained on					
37.5mm	1 1/2"	25mm	1"	1249			
25mm	1"	19mm	3/4"	1250			
19mm	3/4"	12.5mm	1/2"	1251			
12.5mm	1/2"	9.5mm	3/8"	1250			
9.5mm	3/8"	6.3mm	1/4"				
6.3mm	1/4"	4.75mm	No.4				
4.75mm	No.4	2.36mm	No.8				
Total Sample weight, (gm)			A	5000			
Weight of portion Retained on 1.70mmSieve, (gm)			B	3608			
Percent Loss After Test, %		(A-B)/A*100		28			

Plate 3.76 Los Angeles Test form



SETRACO NIGERIA LIMITED

QUALITY CONTROL DEPARTMENT

PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUEL CARRIAGEWAY (SECTION I)

CLIENT : FEDERAL MINISTRY OF WORKS

CONSULTANT : TISCO AND PARTNERS

IN - SITU DRY DENSITY TEST

(Sand Replacement Method - Test Method : BS 1377 Part 9)

Location : *CH 76 + 250 ~ 77 + 600 LHS C/way*

Layer : Milled Asphalt (Subgrade)			*Date : 24-Sep-19*		
Bulk Density of Sand		1.29	Max Dry density (gm/cc)		1.90
Wt. of Sand in Cone		1359	Optm. Moisture Cont. (%)		7.0
CHAINAGE		*77 + 400*	*77 + 500*	*77 + 600*	
OFF: SET		*LHS*	*RHS*	*C/L*	
Layer Thickness	(Cm)	*15*	*15*	*15*	
Wt. of Sand Before Pouring	(gms)	16000	16000	16000	
Wt. of Sand After Pouring	(gms)	10984	10816	10780	
Wt. of Sand in Hole + Cone	(gms)	5016	5184	5220	
Wt. of Sand in Cone	(gms)	1359	1359	1359	
Wt. of Sand in Hole	(gms)	3657	3825	3861	
Volume of Hole	(cm3)	2835	2965	2993	
Wt. of Soil from the Hole	(gms)	5777	6028	6132	
Wet Density	(gm/cc)	2.038	2.033	2.049	
Moisture Content	(%)	6.4	6.8	6.8	
Dry Density	(gm/cc)	1.915	1.904	1.918	
% of Max. Dry Density		**101**	**100**	**101**	

Plate 3.77 In-Situ Test form

3.10.2 AGGREGATE CRUSHING VALUE TEST (ACV TEST)

Aggregate crushing value test provides a relative measure of resistance to crushing under a gradually applied compressive load. For a high quality pavement, aggregates having a low crushing value is preferred.

3.10.2.1 Objectives:

To determine:

1. Determine the aggregate crushing value of coarse aggregate.
2. Assess suitability of coarse aggregates for use in different types of road.

3.10.2.2 Apparatus:

ACV mould with the plunger, Tamping rod, Compressive Testing Machine, Weigh balance

3.10.2.3 Procedures:

1. The Oven dried aggregate sample was sieved. Aggregates passing through sieve size 12.5mm and retained on sieve size 10mm was used for the test.

2. The cylinder was in cylinder on the base plate and weighed as **W.**

3. The ACV mould was filled with the test sample aggregate in three layers of approximate equal depth, each layer is tampered 25 times using the tamping rod.

Plate 3.78 ACV mould and tamping

4. After the third layer was tampered, the tamping rod was made to level off the aggregates at the top of the mould. The total depth filled was 100mm.

5. The plunger was inserted into the ACV mould such as it rested on the top layer of the aggregate.

6. The ACV mould with the aggregate and the plunger in place was placed in the compression testing machine.

7. The Specimen was loaded by the compression machine through the plunger, at a constant rate to a maximum of 40KiloNewton or 10 minutes.

8. And then the Load was released and the specimen is removed. The crushed specimen is dismantled from the ACV mould.

9. Aggregates including the crushed portion were removed from the ACV mould and sieved with sieve size 2.36mm. The materials which passed through the sieve was collected and then weighed as **W2.**

Plate 3.79 loading of the ACV specimen

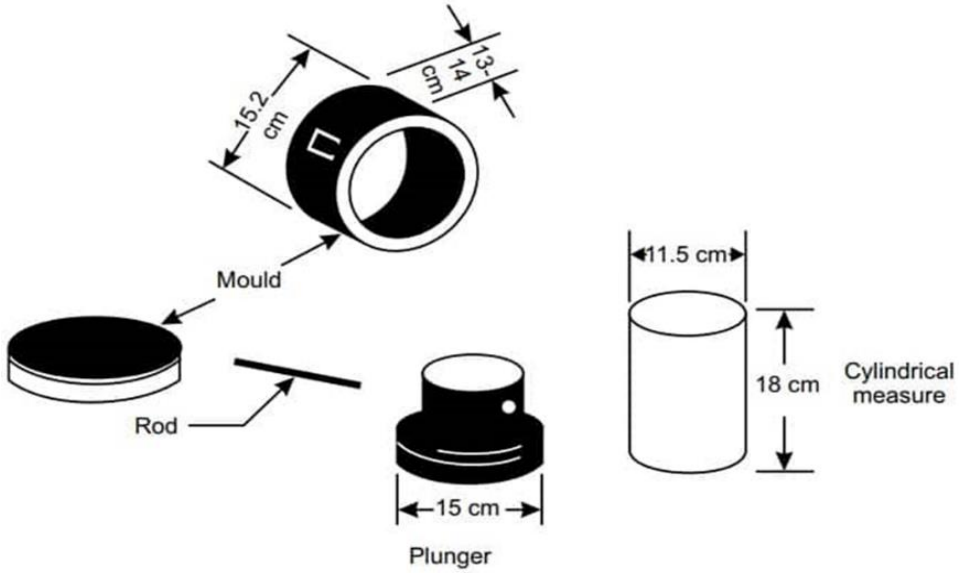


Figure 3.8 showing ACV mould dimension

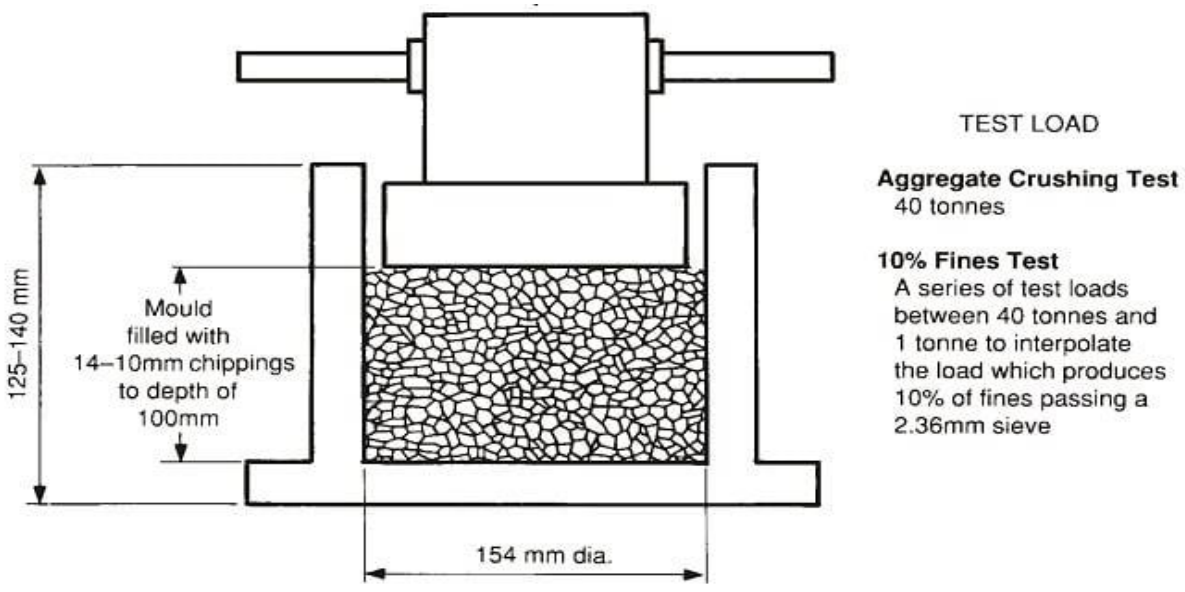

125–140 mm
Mould filled with 14–10mm chippings to depth of 100mm
154 mm dia.
TEST LOAD
Aggregate Crushing Test
40 tonnes
10% Fines Test
A series of test loads between 40 tonnes and 1 tonne to interpolate the load which produces 10% of fines passing a 2.36mm sieve

Figure 3.9 showing the loading of ACV specimen

3.10.2.4 Calculations:

The aggregate crushing value is defined as the percentage of the ratio of the weight fines passing through sieve 2.36 to the weight of the original sample.

Aggregate Crushing Value = $((W_2 / W_1 - W) \times 100)$

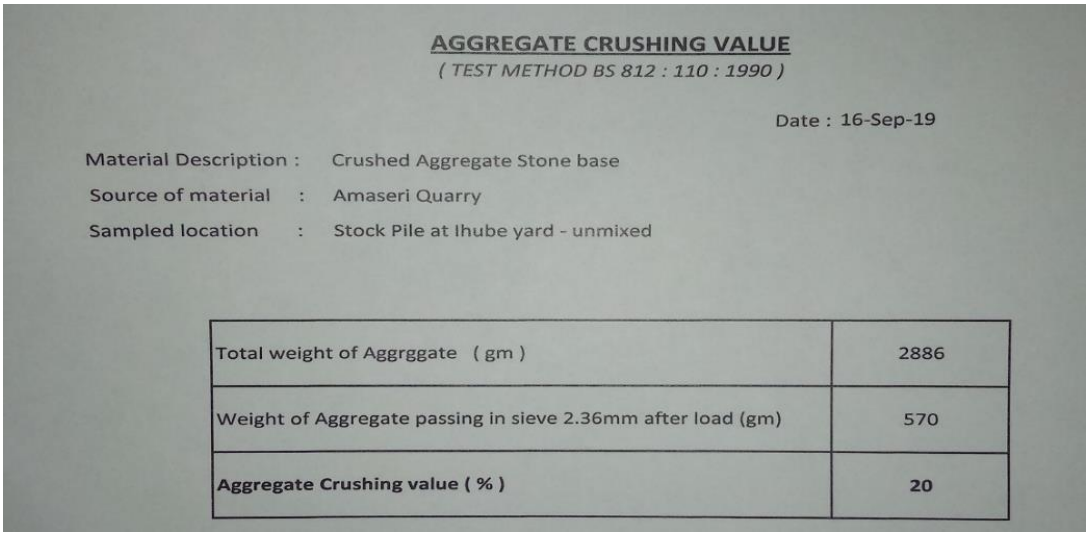
$W_1 - W$ = weight of dry sample

W_2 = Weight of the material passing through sieve size 2.36 mm

Table 3.9 Limits of Aggregate Crushing Value

TYPES OF ROADS / PAVEMENTS	**AGGREGATE CRUSHING VALUE LIMIT**
Flexible pavements	
Water bound macadam	40
Bituminous macadam	30
Bituminous surface dressing	30
Dense mix carpet	30
Rigid Pavements	
Other than wearing course	45
Surface or wearing course	30

3.10.2.6 Test form:



AGGREGATE CRUSHING VALUE

(TEST METHOD BS 812 : 110 : 1990)

Date : 16-Sep-19

Material Description : Crushed Aggregate Stone base

Source of material : Amaseri Quarry

Sampled location : Stock Pile at Ihube yard - unmixed

Total weight of Aggrggate (gm)	2886
Weight of Aggregate passing in sieve 2.36mm after load (gm)	570
Aggregate Crushing value (%)	**20**

Plate 3.80 Aggregate crushing value test result

3.10.3 SPECIFIC GRAVITY OF COARSE AGGREGATES

Specific gravity is the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. Water, has a specific gravity of 1. Specific gravity is important for several reasons.

Specific gravity is essential and critical information for the Hot mix Asphalt Design Engineer. The Value is used in calculating air voids, voids in mineral aggregate (VMA) and voids filled by asphalt (VFA). All are critical to a well performing and durable asphalt mix. Water absorption can also be an indicator of asphalt absorption. A highly absorptive aggregate may lead to a low durability of asphalt mix.

In Portland cement concrete, the absorption is important in determining the net water-cement ratio in the concrete mix.

Though high specific gravity is an indication of high strength, it is not possible to judge the suitability of an aggregate sample without finding the mechanical properties such as aggregate crushing, impact and abrasion values.

3.10.3.1 Objectives:

1. To determine the strength or quality of the material
2. To determine the water absorption of aggregate.

3.10.3.2 Apparatus

Weigh balance, wire mesh, Oven, Wire mesh, water tank, absorbent clothes,

3.10.3.3 Procedures

1. About 2kilogram of the aggregate was washed thoroughly to remove the fines and soaked for 24hours.

Plate 3.81 Washing, soaking of Aggregate and Specific gravity bench

2. The wire mesh basket and the sample were weighed while suspended in a distilled water between a 22-32 ℃. The weight is taken to be **W1.** The bench is sturdy, heavy gauge painted steel and features (51mm) diameter holes in the top balance platform for weigh-below hook suspended of samples and thermometers. The lower support doubles as a shelf that can be adjusted to lift heavy-duty plastic water tank, ordered separately.

3. The basket and the sample were removed from water and was drained using absorbent clothes, by rolling up the aggregate into the towel, and then shaking and rolling from side to side. The aggregate was dried to a condition of saturated surface dry (SSD).

4. The wire mesh basket was returned to the tank of water and jolted 25times and weighed in water. The weight was taken as **W2.**

5. The dried SSD aggregate was weighed and taken as **W3.**

6. The aggregate was oven dried for 24 hours. It was allowed to cool and weighed. The weight was taken as **W4.**

3.10.3.4 Calculations:

Weight of saturated aggregate suspended in water with the wire mesh basket **= W1**

Weight of wire mesh basket suspended in water = **W2**

Weight of saturated surface dry aggregate in air = **W3**

Weight of Oven dry aggregate = **W4**

Weight of saturated aggregate in water = **W1- W2**

Weight of water equal to the volume of the aggregate = **W3-(W1-W2)**

Specific gravity = W3/ (W3-(W1-W2))

Apparent specific gravity = W4/ (W4-(W11-W2)

Water Absorption = ((W3-W4)/W4) X 100)

3.10.3.5 Limits:

The specific gravity of aggregates normally used in road construction ranges from about **2.5 to 3.0** with an average of about **2.68.**

Water absorption shall not be more than **0.6 per unit by weight.**

3.10.3.6 Test form:

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CLIENT : FEDERAL MINISTRY OF WORKS
CONSULTANT : TISCO AND PARTNERS

SPECIFIC GRAVITY AND WATER ABSORPTION OF COARSE AGGREGATE

(Test method BS 812: Part 2 : 1995. method : 5.3)

Date : 4-Oct-19

Aggregate Description : 1" (15 - 28)mm
Aggregate Source : Uturu Crusher
Sampled from : Asphalt Plant Stock pile

Sample No		1	2
(A) Weight of oven dry sample	(gm)	1523.3	1435.4
(B) Weight of SSD sample	(gm)	1533.5	1444.6
(C) Weight of sample in water	(gm)	1001.3	942.5
Bulk pecific gravity (Dry basis)	A/(B - C)	2.862	2.859
Bulk pecific gravity (SSD basis)	B/(B - C)	2.881	2.877
Apparent specific gravity	A/(A - C)	2.918	2.912
Water absorption	((B - A)/A) x 100	0.67	0.64

Bulk specific gravity (Dry basis)	**2.861**
Bulk specific gravity (SSD basis)	**2.879**
Apparent specific gravity	**2.915**
Water absorption	**0.66**

Plate 3.82 Specific gravity test form

3.10.4 FLAKINESS INDEX TEST

The particle shape of aggregate is determined by the percentage of flaky and elongated particles contained in it. For base course and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable. Flaky and elongated sized particle causes inherent weakness with possibility of breaking down under heavy loads. Both

flakiness and elongation tests are necessary and carried out on the same aggregate sample. Flaky and Elongated particles should be avoided in pavement construction, especially the surface course.

3.10.4.1 Aim: To determine the flakiness index of the given aggregate

3.10.4.2 Apparatus: weigh balance, flakiness metal gauge, set of sieves.

3.10.4.3 Procedures:

1. A sample of the aggregate to be tested shall be washed and oven dried.
2. The oven dried sample was sieved using the set of sieves with sizes…
3. The aggregate retained on each sieve was weighed and distributed into different pans. The total weight of aggregate retained was taken to be **W1.**

Plate 3.83 The set of sieves and aggregate size distribution

4. Each fraction of aggregate was gauge by passing them singly through the flakiness metal gauge, in turn of thickness. The width of the slot used on the flakiness gauge corresponds to the sieve size on which the aggregate are retained.
5. The aggregate passing through the flakiness gauge from each fraction, was weighed and the total weight was taken to be **W2**.

3.10.4.4 Calculations:

W1 = Weight of aggregate retained on specified sieves

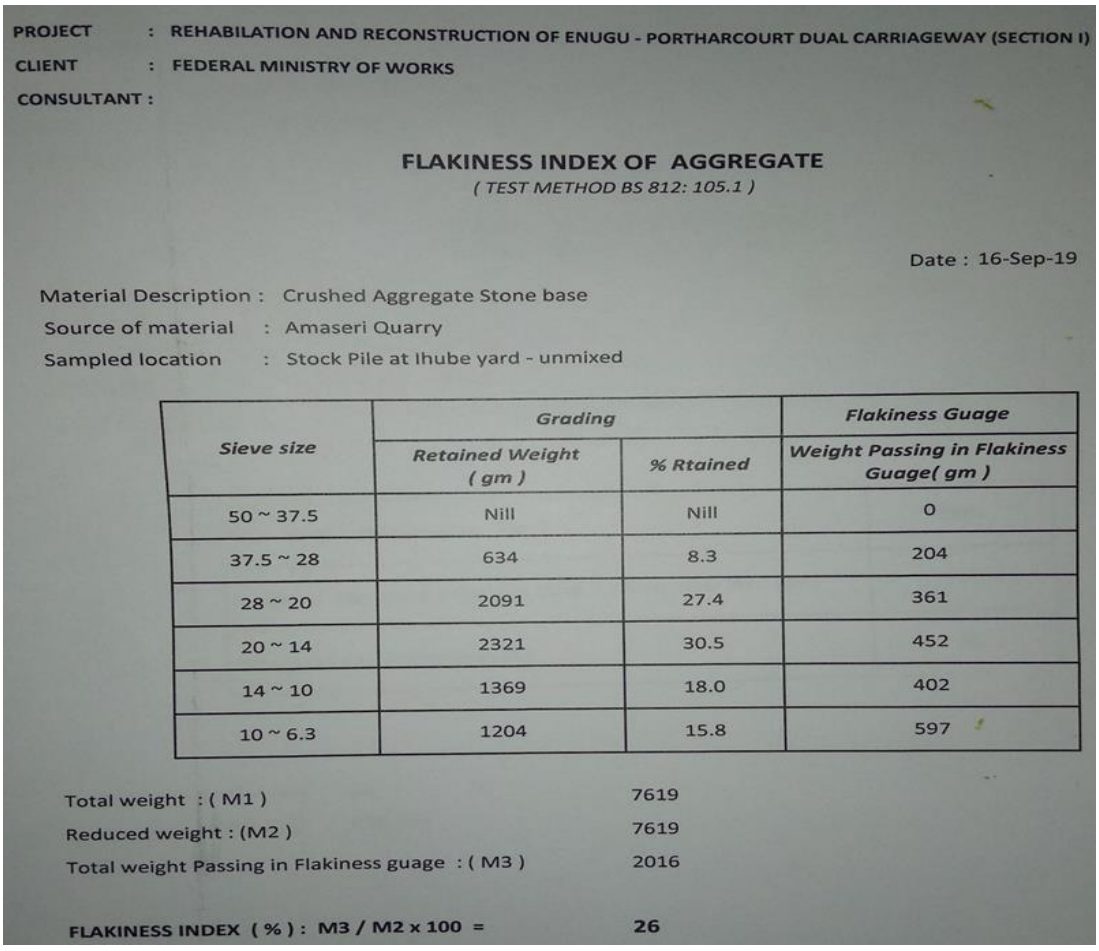
W2 = Total weight of aggregate passing through the flakiness gauge.

FLAKINESS INDEX = (W2/W1 X 100)

Table 3.10 IRC recommendations for maximum limits of flakiness index

S/N	TYPE OF PAVEMENT	MAXIMUM LIMITS OF FLAKINESS INDEX (%)
1	Bituminous carpet	30
2 (i)	Bituminous / asphaltic concrete	25
(ii)	Bituminous penetration macadam	
(iii)	Bituminous surface dressing (single coat, two coats and precoated)	
(iv)	Built up spray grout	
3 (i)	Bituminous macadam	15
(ii)	WBM base course and surface course	

3.10.4.5 Test form:



PROJECT : REHABILATION AND RECONSTRUCTION OF ENUGU - PORTHARCOURT DUAL CARRIAGEWAY (SECTION I)
CLIENT : FEDERAL MINISTRY OF WORKS
CONSULTANT :

FLAKINESS INDEX OF AGGREGATE
(TEST METHOD BS 812: 105.1)

Date : 16-Sep-19

Material Description : Crushed Aggregate Stone base
Source of material : Amaseri Quarry
Sampled location : Stock Pile at Ihube yard - unmixed

Sieve size	Grading		Flakiness Guage
	Retained Weight (gm)	% Rtained	Weight Passing in Flakiness Guage(gm)
50 ~ 37.5	Nill	Nill	0
37.5 ~ 28	634	8.3	204
28 ~ 20	2091	27.4	361
20 ~ 14	2321	30.5	452
14 ~ 10	1369	18.0	402
10 ~ 6.3	1204	15.8	597

Total weight : (M1) 7619
Reduced weight : (M2) 7619
Total weight Passing in Flakiness guage : (M3) 2016

FLAKINESS INDEX (%) : M3 / M2 x 100 = 26

Plate 3.84 Flakiness Index test form

3.10.5 ELONGATION FLAKINESS INDEX TEST

3.10.5.1 Apparatus: weigh balance, elongation metal gauge, set of sieves.

3.10.5.2 Procedures:

1. A sample of the aggregate to be tested shall be washed and oven dried.

2. The oven dried sample was sieved using the set of sieves with sizes… The aggregate retained on each sieve was weighed and distributed into different pans. The total weight of aggregate retained was taken to be **W1.**

3. Each fraction of aggregate was gauged in turn for length, by passing them singly through the elongation metal gauge. The length of the slot used on the elongation gauge corresponds to the sieve size on which the aggregate were retained.

Plate 3.85 Elongation Gauging

4. The aggregate retained on the elongation gauge from each fraction, was weighed and the total weight was taken to be **W2**.

3.10.5.3 Calculations:

W1 = Weight of aggregate retained on specified sieves

W2 = Total weight of aggregate passing through the flakiness gauge.

ELONGATION INDEX = (W2/W1 X 100)

3.10.5.4 Limits:

The limit of elongated particles in the mixes is 45%. If the elongated particles are greater than 45%, then the aggregate is considered undesirable for the intended use.

For pavement, either bituminous or non-bituminous, the elongation index of coarse aggregate should not be more than 15%.

3.10.5.5 Test form:

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CLIENT : FEDERAL MINISTRY OF WORKS
CONSULTANT :

ELONGATION INDEX OF AGGREGATE
(TEST METHOD BS 812: 105.2)

Date : 20-Jul-19

Material Description : Crushed Aggregate Stone base
Source of material : Amaseri Quarry
Sampled location : Stock Pile at Ihube yard

Sieve size	*Grading*		*Elongation Guage*
	Retained Weight (gm)	*% Rtained*	*Weight Retained in Elongation Guage(gm)*
50 ~ 37.5	Nill	Nill	Nill
37.5 ~ 28	700	12.1	124
28 ~ 20	1560	27.0	525
20 ~ 14	1406	24.4	465
14 ~ 10	917	15.9	466
10 ~ 6.3	1191	20.6	493

Total weight : (M1) 5774
Reduced weight : (M2) 5774
Total weight Retained in Elongation guage : (M3) 2073

ELONGATION INDEX (%) : M3 / M2 x 100 = 36

Plate 3.86 Elongation Index Test form

3.10.6 BULK DENSITY TEST OF AGGREGATE

3.10.6.1 Objective: Determination of unit weight or bulk density and void of aggregate

3.10.6.2 Apparatus: Weigh balance, Bulk density cylinder of 15litre capacity, tamping rod

RODED Bulk Density (compacted)

3.10.6.3 Procedures:

1. Aggregate sample was collected and a percentage moisture may be required.
2. The volume of cylinder to be used was calculated and recorded as **V**
3. The cylindrical metal was filled with aggregate to about one third of the height of the cylinder. The aggregate was then tamped 25 times.
4. Another layer of aggregate was added to about two-third of the height of the cylinder, and given 25 strokes of tamping rod.
5. The cylinder was filled with aggregate till overflowing occurred and tamped 25times.
6. Surplus aggregate was removed using the tamping rod as a straight edge.
7. The filled cylinder was weighed and the weight was taken as **W.**

Plate 3.87 Tamping and leveling

LOOSE Bulk Density

3.10.6.4 Procedures

1. Aggregate sample was collected and a percentage moisture may be required.
2. The volume of cylinder to be used was calculated and recorded as **V.**
3. The cylinder was filled with aggregate using a scoop till overflowing occurred.
4. The top surface of the aggregate in the cylinder was levelled using the tamping rod as a straight edge.
5. The weight of the aggregate was determined and recorded as **W.**

3.10.6.5 Calculations:

Volume of cylinder = $\mathbf{V} = \pi r^2 h$

Weight of aggregate in cylinder = **W**

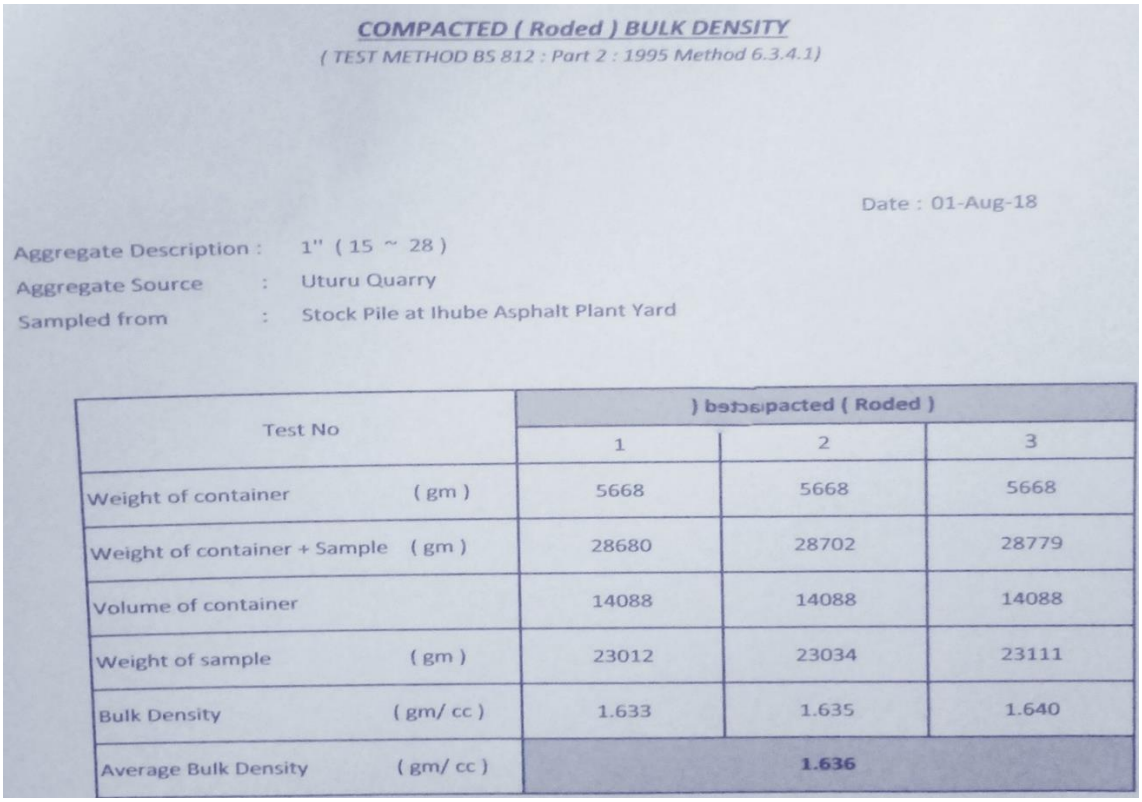
Unit weight or bulk density (Y) = W/V

The percentage voids = [(G – Y)/G] ×100

Where G = Specific gravity of aggregate

Y = Bulk density

3.10.6.6 Test form:



COMPACTED (Roded) BULK DENSITY

(TEST METHOD BS 812 : Part 2 : 1995 Method 6.3.4.1)

Date : 01-Aug-18

Aggregate Description : 1" (15 ~ 28)

Aggregate Source : Uturu Quarry

Sampled from : Stock Pile at Ihube Asphalt Plant Yard

Test No		) bətɔʁpacted (Roded)		
		1	2	3
Weight of container	(gm)	5668	5668	5668
Weight of container + Sample	(gm)	28680	28702	28779
Volume of container		14088	14088	14088
Weight of sample	(gm)	23012	23034	23111
Bulk Density	(gm/ cc)	1.633	1.635	1.640
Average Bulk Density	(gm/ cc)		**1.636**	

Plate 3.88 Bulk density test form

3.10.7 SPECIFIC GRAVITY AND WATER ABSORBTION OF FINE AGGREGATE

Specific gravity is critical for the hot mix Asphalt design. Specific gravity had been explained earlier.

3.10.7.1 Apparatus: Weigh balance, specific gravity cone (Abraham cone) and it's tamping rod, Volumetric flask (pycnometer) and a water bottle.

3.10.7.2 Procedures:

1. The soil sample was washed and sieved using sieve No 4. (4.75mm).

2. The soil sample was spread on a flat, non–absorbent surface and stirred occasionally to assist in homogenous drying. A current of warm air was also used to assist the drying.

3. The slump was checked at intervals, as procedure 2 above continues using the cone. The filled cone was given 25 light drops of the tamping rod. The slump was checked this way until shearing occurs. A shearing slump indicates the soil readiness for test, so the drying stops after a shearing slump occurs.

Plate 3.89 Specific gravity test procedures

4. Quantity of the saturated, surface dry (SSD) sample, enough for two trials was weighed as **A.**

5. Water was filled into the pycnometer up to the caliberation line and then weighed. The weight was recorded as **C**.

6. The SSD sand sample was poured into the pycnometer which already contains little amount of water, shaked and then additional water was added to reach the caliberation line. The weight was taken and recorded as **D**. Shaking is necessary to eliminate entrapped air.

7. Offloading of the specimen from the pycnometer was done and the sand was oven dried. The oven dried sample was weighed and recorded as **B**.

8. All the procedures above were followed to have two simultaneous trials.

3.10.7.3 Calculations:

Weight of SSD sample (g) = **A**

Weight of Oven dry sample (g) = **B**

Weight of pycnometer + water (g) = **C**

Weight of pycnometer + water + SSD sample (g) = **D**

Weight of Sample in water = **E**

E = D - C

Volume of sample **= F**

F = A – E

Bulk specific gravity (Dry basis) = **B/F**

Bulk Specific gravity (SSD basis) = **A/F**

Apparent specific gravity = B / (B –E)

Water Absorption = ((A – B) / B) ×100

3.11 QUALITY CONTROL MEASURES OF SURFACE COURSE (WEARING)

The wearing course is the layer in contact with traffic loads and normally contains the highest quality materials. The highway surface course (binder and wearing) layers have similar quality control measures: of which some have been discussed previously in section 3.10 of this report work. Other tests are as stated in table 3.1 which includes marshall properties, etc.

3.11.1 DETERMINATION OF PENETRATION VALUE OF BITUMEN

Penetration value is a measurement of hardness or consistency of bituminous material. It is the vertical distance traversed or penetrated by the point of a standard needle in to the bituminous material under specific conditions of load, time and temperature.

3.11.1.1 Objectives: To determine the consistency of bituminous material

3.11.1.2 Apparatus: Metallic dish 55mm and 35mm in depth, needle, needle, Water bath maintained at 25.0 ± 0.1℃ containing not less than 10 litres of water and Penetration apparatus

3.11.1.3 Procedures:

1. Enough of bitumen was sampled from the stock tank and distributed into the metallic dishes such that it is filled to the brim. The samples were allowed to cool and then transferred to into the water bath such that the dishes were completely immersed. The water bath was kept at a temperature of 25.0 ± 0.1℃ for one hour.
2. After an hour, the specimens were placed upon the stand of the penetration apparatus. The needle was adjusted to make contact with the surface of the sample and the pointer dial was made to read zero. The needle was released for 5 seconds and then the penetration machine was adjusted to measure the distance penetrated.
3. Three readings at points on the surface of the each samples not less than 10mm from the side of the dish.

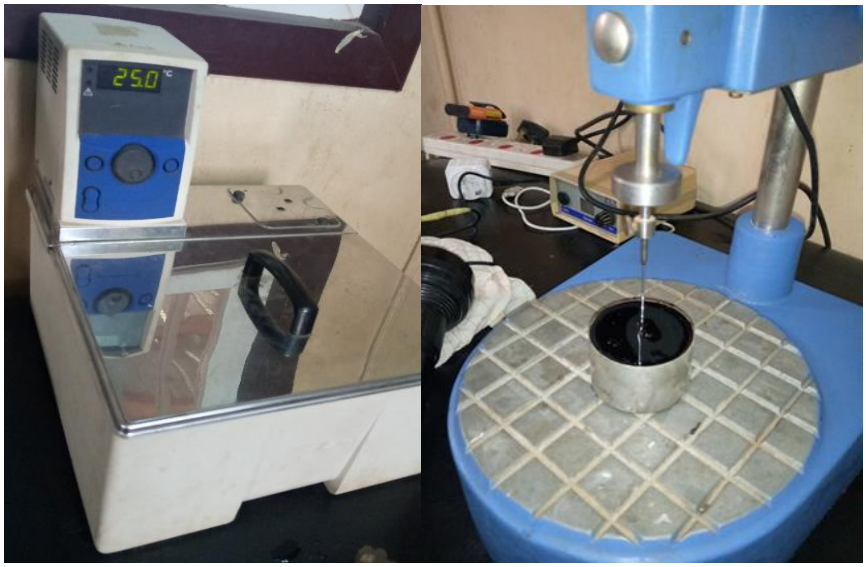


Plate 3.90 Bitumen being penetrated

3.11.1.4 Calculations:

The total load equals 100 ± 0.25grams including the weight of the needle, carrier and super-imposed weights.

Time and Temperature equals 5seconds and 25℃ respectively.

Average Penetration = (Sum of all Penetrations / 9)

3.11.1.5 Test form:

BITUMEN PENETRATION TEST

(Test Method ASTM: D 05 - 97)

Date sampled : 07 – 09 – 19

Date tested : 09 – 09 – 19

Sample Description: 60/70 Bitumen

Source of Material : Matrix

Truck No : JJJ 108 X4

Test No	1	2	3	4	5	6	7	8	9
Load (gm)	100	100	100	100	100	100	100	100	100
Time (S)	5	5	5	5	5	5	5	5	5
Temperature (°C)	25	25	25	25	25	25	25	25	25
Penetration	62	61	62	60	60	63	64	63	62
Average Penetration	62								

Plate 3.91 Bitumen penetration test form

3.12 PETROLEUM DENSITY TEST

Petroleum products such as petrol and diesel were also tested in the laboratory for density and flushed of water before offloading from the tanker. This responsibility falls under the quality control department but is not in any way related to the materials used as part of the highway construction. Fuel are brought to the yard for stocking, to be consumed various vehicles and machineries used for the purpose of construction. Samples of these products are brought to the material testing laboratory for density test.

The density of a fuel is the mass of fuel per unit volume. In some cases, the density is expressed as a specific gravity or relative density. The density is determined by the quality of crude used to produce the fuel and the refining process. Fuel with higher density means more 'bang for the bulk'- that is, "value in return for money". Usually, the density of a product impacts heating value or energy content. Once the specific gravity of the fuel is known, a decision of jet tuning can be made.

3.12.1 Objective: To determine the temperature and the density of petroleum products

3.12.2 Apparatus: Water proof thermometer, sensitive glass hydrometer, Cylinder, water finding paste, rod, rags,

3.12.3 Procedures:

1. The three compartments of a petroleum tanker was checked for water content. Since water is denser than a petroleum product, water settles beneath the tankers if present. Sample fuel is gotten from the tanker access located beneath the tank, leading to each compartments.

Plate 3.92 finding water in a petroleum sample

2. Using the water finding paste as indicator, the paste is rubbed to the rod and dipped into each petroleum sample, a color change from yellow to pink indicates the presence of water content. The three compartments are checked and flushed till the color finding paste remains yellow, which represents zero water content.

3. The petroleum product is sampled from each compartments, through top and bottom access, thus brought to the laboratory for density test.

4. Each sample is poured into the cylinder while the hydrometer was inserted and allowed to settle. The density of each sample is taken, by this.

Plate 3.93 Density Test of petroleum

5. The thermometer was inserted and the temperature reading is taken.

3.12.4 Calculations:

Average Temperature (top and bottom) $= \sum$ Temperature (top and bottom) / 6

Average Density (top and bottom) $= \sum$ Density (top and bottom) / 6

Table 3.11 Density (recommended by Nigeria industrial standard)

Product	Gravity Temperature	Density Range
Diesel	Specific Gravity @ 15°C g/ml	0.820 - 0.870
Petrol	Specific Gravity @ 15°C g/ml	0.720 - 0.780
Kerosine	Specific Gravity @ 15°C g/ml	0.775 - 0.825

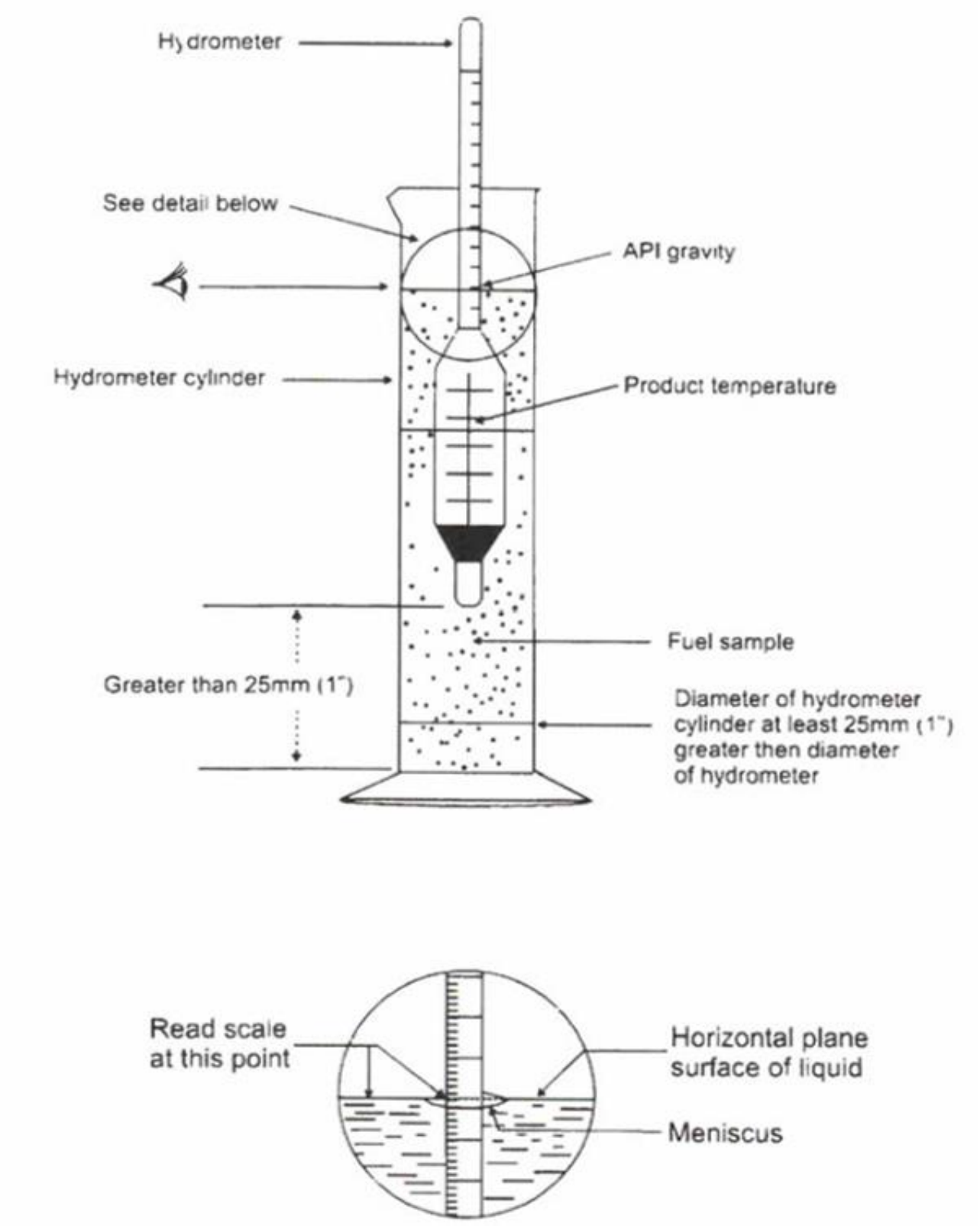
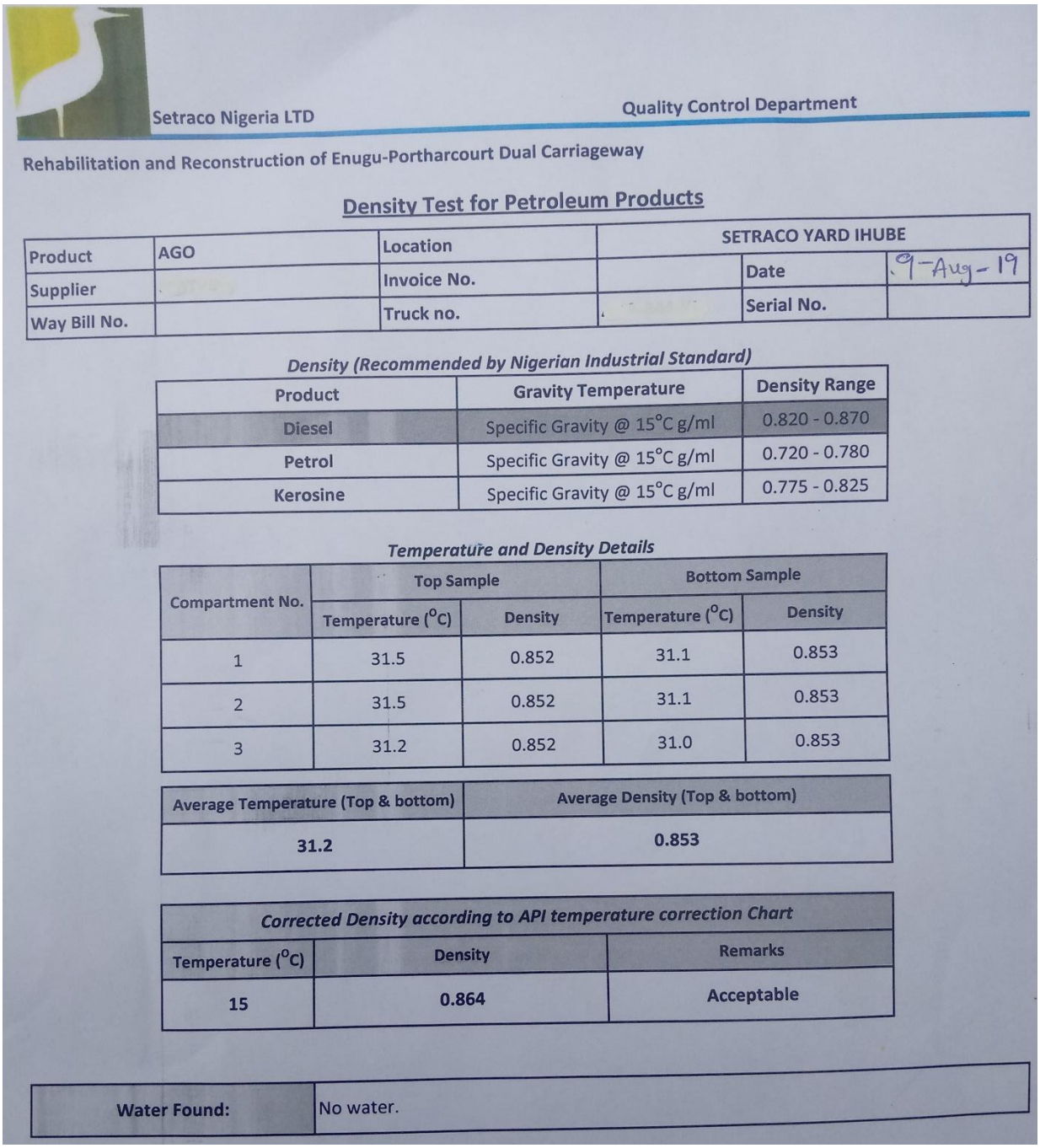


Figure 3.10 Apparatus set up and pressure reading

3.12.5 Test form:



Setraco Nigeria LTD — Quality Control Department

Rehabilitation and Reconstruction of Enugu-Portharcourt Dual Carriageway

Density Test for Petroleum Products

Product	AGO	Location	SETRACO YARD IHUBE		
Supplier		Invoice No.		Date	9-Aug-19
Way Bill No.		Truck no.		Serial No.	

Density (Recommended by Nigerian Industrial Standard)

Product	Gravity Temperature	Density Range
Diesel	Specific Gravity @ 15°C g/ml	0.820 - 0.870
Petrol	Specific Gravity @ 15°C g/ml	0.720 - 0.780
Kerosine	Specific Gravity @ 15°C g/ml	0.775 - 0.825

Temperature and Density Details

Compartment No.	Top Sample		Bottom Sample	
	Temperature (°C)	Density	Temperature (°C)	Density
1	31.5	0.852	31.1	0.853
2	31.5	0.852	31.1	0.853
3	31.2	0.852	31.0	0.853

Average Temperature (Top & bottom)	Average Density (Top & bottom)
31.2	0.853

Corrected Density according to API temperature correction Chart		
Temperature (°C)	Density	Remarks
15	0.864	Acceptable

Water Found:	No water.

Plate 3.94 Density Petroleum test Result

CHAPTER FOUR

4.1 PROBLEMS ENCOUNTERED DURING THE PROGRAM

At Setraco Nigeria limited and some parts of my environment being South Eastern Nigeria, the challenges encountered were just minimal and under control. It is not uncommon to hear students on their Industrial Attachment (IT) or internship lament over their unpleasant experiences, especially the challenges encountered in the process of finding a firm to accommodate and support them financially. Thus, it should be noted that the course of the training did not go without some challenges. Challenges were faced before getting a placement and during the course of learning. Some of these challenges include:

- Among the major issues faced by institutions is the small number of IT students taken in by organizations at any given time. Given that there are thousands of students from various public and private universities seeking placements at almost the same period of time, industrial training has become a competitive endeavor for students.
- There is not enough work assigned to IT students causing boredom and underutilization of their acquired skills.
- Many companies were just looking for cheap labour and thus, fitting students to areas they lack man-power and not their areas of specialization.
- Running errands requiring no special skills or intellectual knowledge became the order of the day.
- Getting placement didn’t come as easy as expected. This caused part of the six months to be wasted on searching for placement.
- Because IT students are just glad to get a foot in the door, some work places may take advantage of them by giving them very long hours of dull and repetitive works.
- There is also the issue of allowances paid to students, where there are cases where students do not receive any allowance at all. This puts a burden on students who have to bear the cost of accommodation and travel expenses during their industrial training period. This in turn means that students prefer to do their training at organisations near their homes, sometimes losing the opportunity to maximise the full potential of their training experience.

- Apart from the selection of students, one of the main issues about industrial training brought up by companies is the duration of the training period. Thus, institutions whose students have longer training periods are more likely to be selected.
- Another issue that has been highlighted is the lack of structure in industrial training programmes, in terms of what types of tasks trainees are expected to perform and how the training period should be.
- There is lack of partnership and collaboration between the companies and institutions of learning.

4.2 SOLUTION PROFERRED

Notwithstanding, the program is of great benefits and should continue. To get the best out of it, I suggest the following:

- While it is acknowledged that trainees have limited knowledge, skills and experience at the time of training, industries should not just assign trainees with mundane tasks but provide a more structured training programme with appropriate supervision so that the trainees actually learn on-the-job skills making it a meaningful learning experience.
- The industrial training fund (ITF) should look for ways to provide a longer training period and a more structured mechanism for industrial training.
- The first is increased collaboration between academia in industry so that both parties can communicate their expectations to each other, in area pertaining to curriculum development, research opportunities, and career briefings to students, soft-skill development as well as industrial training programmes.
- Incentives for industry to take on industrial trainees perhaps in the form of tax relief or financial grants for organisations that take on a stipulated number of trainees per year.
- Companies should also pay students at least a nominal allowance to cover their daily expenses.

CHAPTER FIVE

5.1 CONCLUSION

The Industrial Training Program, in my own opinion is a good idea as its plan to expose students to real life experience is not failing. It has practically exposed me to how the work force and business world seems, outside theories. Being an industrial trainee at Setraco Nigeria limited for the stipulated SIWES period was indeed enlightening, insightful and elevating. It was an exposure to the construction industry. It was also a privilege to see the practical aspect of some theoreties I had been taught. In the course of my training, I got accustomed to some construction operations. Also, I develop more industrial/interpersonal relations and social skills. Having an industrial training component in a degree programme can add tremendous value to any degree programme, particularly as it can enhance the employability skills of graduates. Feedback obtained from industry, such as on the lack of seriousness of students, must be taken seriously.

5.2 RECOMMENDATION

To Industrial Training Fund (ITF)

- Companies should be encourage to tell their students all about the mode of operation and processes involved in their manufacturing work, as it relates to the student's field; without restraining their access to knowledge that may be beneficial to them in the future.
- Students should be supervised regularly to reduce absenteeism and nonchalant attitude towards work.
- Companies and industries should be enlightened with the relevance of Industrial Training and the benefits of recruiting IT students, therebymaking it easier for students to secure placement

To students

- Student should be obedient to constituted authorities and adhere strictly to instruction
- Student should not be too forward so as to learn all he needs to know.
- Student should make judicious use of scheme to empower themselves.
- I hereby advice all intending I.T. students to focus on the experience they will acquire rather than the financial rewards. Even when money is not involved.

To FUTA

- Regular visitation by FUTA supervisors in order to know the various important issues affecting students during their training.

- The institution also helps in securing placement for their students.

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